RADIO and ELECTRICAL Review

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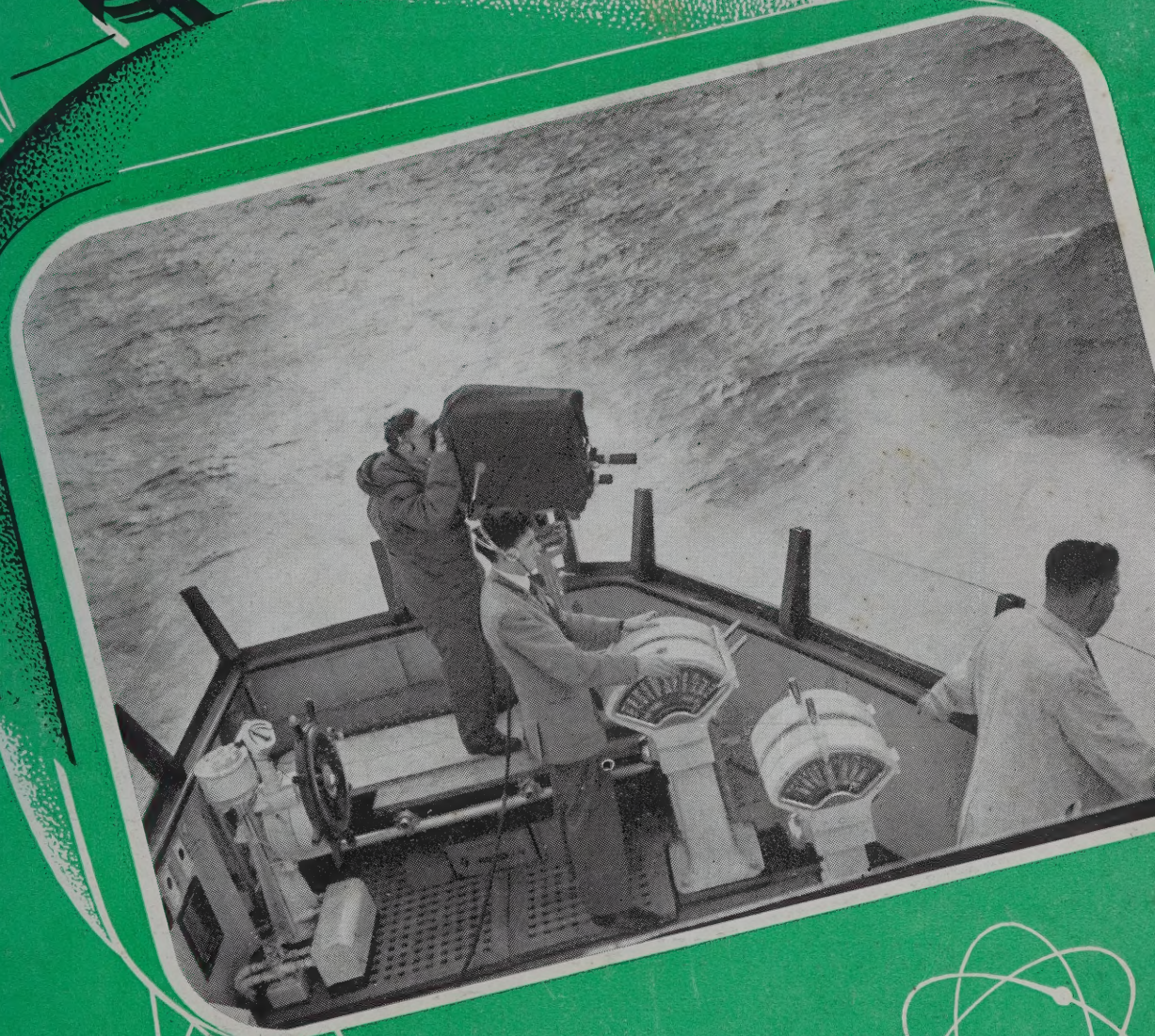

APRIL, 1st 1955

VOL. 10, NO. 2

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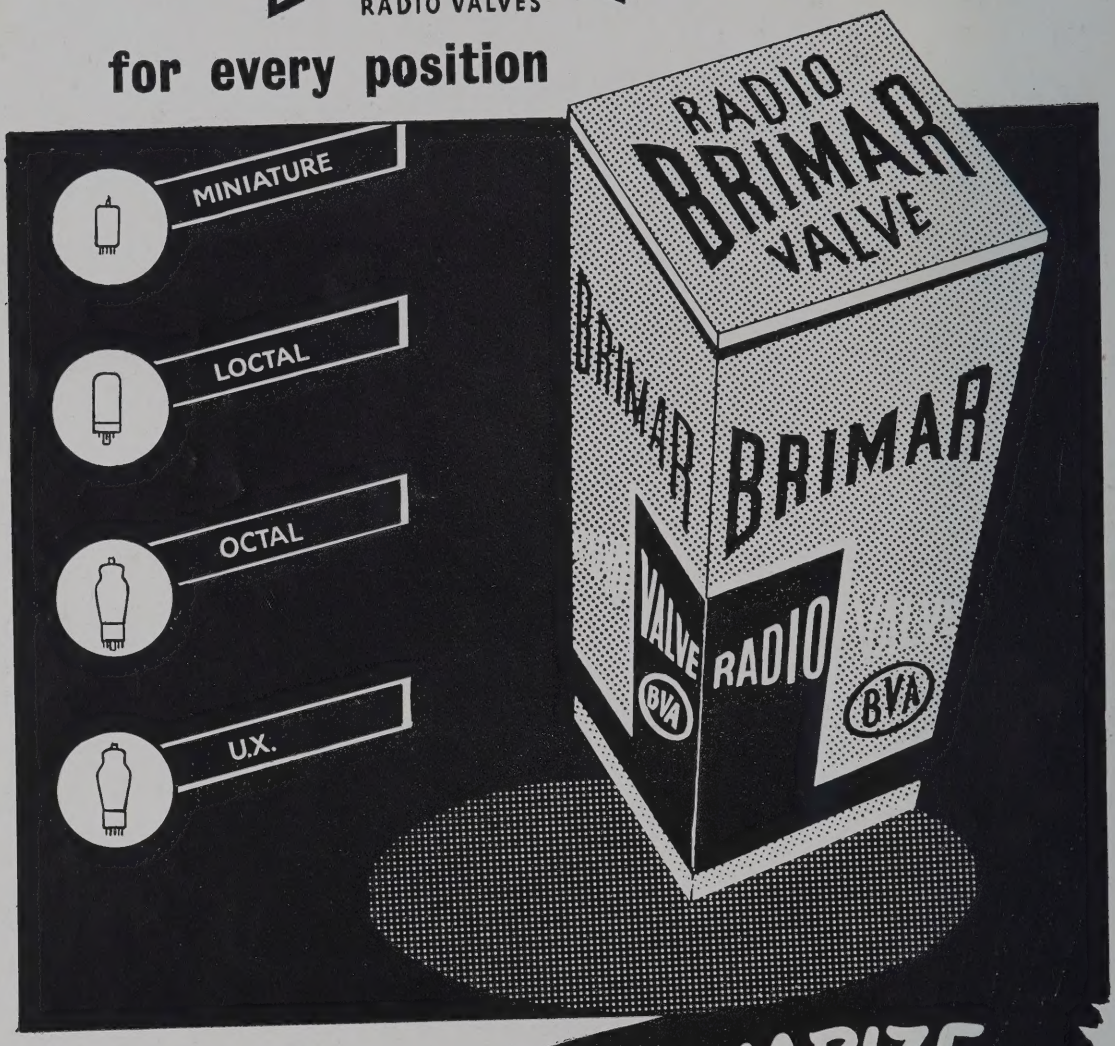
for every position



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Radio and Electrical Review

Our Cover Picture this month shows the Marconi Image Orthicon Camera in use during the historic B.B.C. TV broadcast from the s.s. "Lord Warden"—the first occasion on which a TV programme was transmitted from a moving ship at sea. The broadcast took place on 26th September, 1955 while the ship was crossing from Boulogne to Dover.

Official Journal of
The N.Z. Electronics Institute (Inc.).
The N.Z. Radio and Television Manufacturers' Federation.
The N.Z. Radio and Electrical Traders' Federation.
N.Z. Radio, TV and Electrical Assn. (Inc.).

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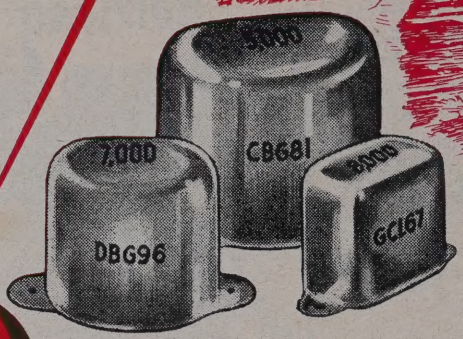


ROLA

ISOCORE

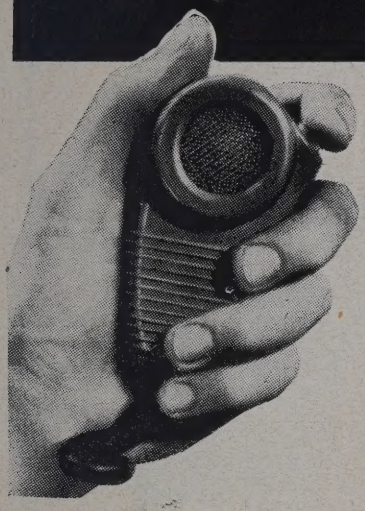
Transformers

Ten years ago this month, Rola researchers were completing laboratory tests on a revolutionary new output transformer – the Isocore.

So advanced was its design that today, with production topping the 600,000 mark, Rola Isocore transformers are still leaders in their field.

Sealed against moisture, fully protected against the corrosive effects of electrolytic action and individually tailored to provide best power transfer and frequency response from the valve with which it is to be used, the Rola Isocore transformer is first choice with all who really know their radio.

VITAVOX loudspeakers and microphones



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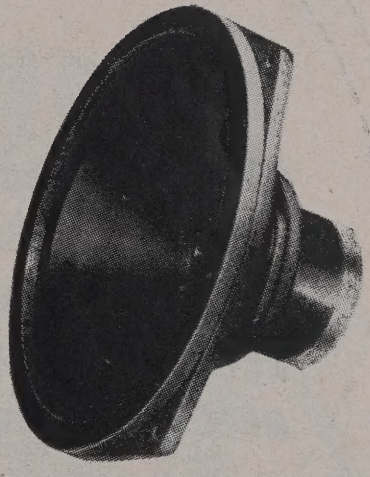

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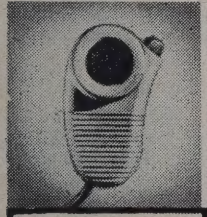
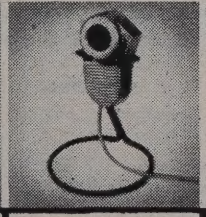


Type B.51 is a Piezo Crystal Microphone with a choice of four different "press-to-talk" switching arrangements or without switch.

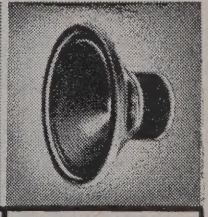


Type B.52 Microphone incorporates matching transformer in place of switch and connects to grid or medium impedance lines.

Type "A" Dynamic Microphones have for some time, been the favourite instrument for high grade sound reinforcement

The GP.1 Pressure Unit is of minimum size and weight consistent with a high standard of performance and reliability.

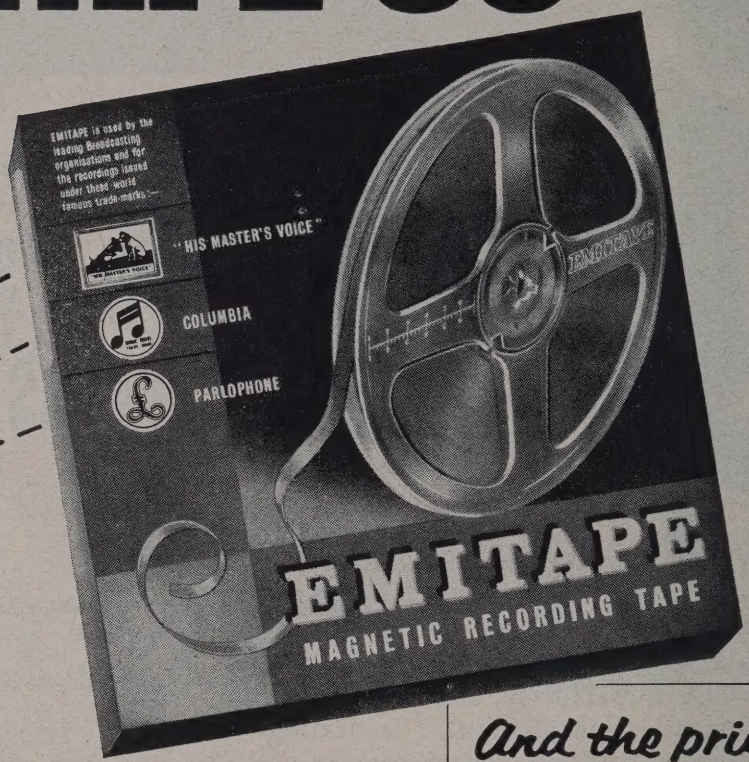
A wide range of horns includes Multicell, Co Mounting and Circular Exponential types designed to give maximum efficiency.



K12/10 and K12/20 cone type moving coil loudspeakers incorporate the latest high efficiency magnet systems. P.H.C. 10 and 20 W.

Here is something really NEW!

EMITAPE "88"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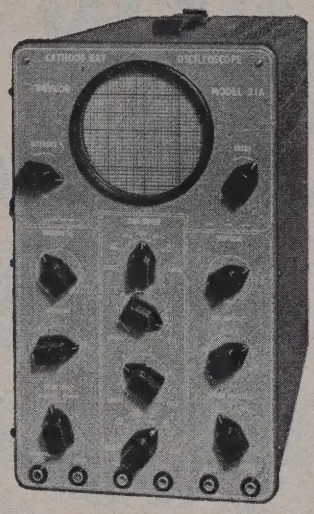

- 4 in. C.R. Tube Electrostatic Deflection.
- Time base from below 10 c/s. up to 500 kc/s.
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Also available TAYLOR WIDE-RANGE R.C. OSCILLATOR MODEL 191A, designed for General Service and Laboratory work.

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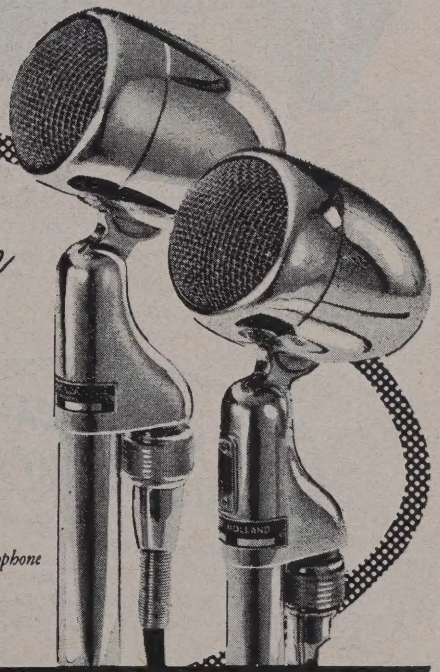
Ronette G-210 *Streamlined microphone*



One of the finest all-purpose microphones ever made by Ronette is this type G-210. Chrome plated die-cast housing with patented "Filtercel" cartridge. Available with several types of voltage/frequency response curves. Type GS-210 has noiseless on-off switch. For use with long lines these models are available with built-in 200 Ω line transformer.

G-210 type microphones are supplied with screened standard microphone connector. 5/8 -27 thread for all normal stands.

Further information will be gladly supplied upon request.

FAMOUS MICROPHONES

GREEN & COOPER LTD.

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This amazing new 5 valve Autocrat is available for either 6 or 12 volt circuits. Ask for a demonstration — test its power and performance for yourself.

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Autocrat

5 VALVE

CAR RADIO

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A.2

Osram VALVES

Pointers for Designers

AND CONSTRUCTORS
NUMBER ELEVEN

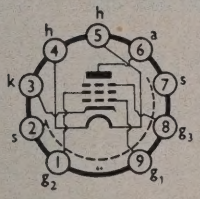
VALVES FOR TAPE RECORDERS

Service in tape recorder amplifiers makes stringent demands on the valves used, particularly in the early stages.

Operation in high gain circuits with a considerable degree of bass boost, and in a confined space in close proximity to a loudspeaker, places a premium on freedom from microphony and hum.

The typical Osram valve line-up shown has proved entirely satisfactory in practice for tape recorder applications. The use of the Z729 low noise pentode, allied with a suitable circuit layout, ensures the virtual elimination of induced hum.

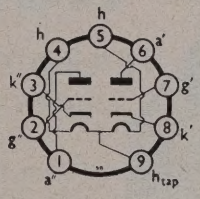
INPUT STAGE
Z729
low noise pentode



V_h	6.3V
I_h	0.2A
V_a	250V
V_{g2}	140V
g_m	1.85m/AV
V_{hum}	1.5μV
$R_{g_1\text{-}k}$	=470kΩ

Base B9A

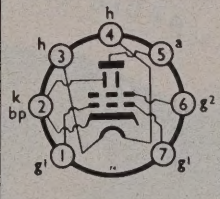
Tone correction and intermediate stages
B309
double triode



V_h	6.3V
I_h	0.6A
V_a	250V
g_m	5.5 mA/V
r_a	10 kΩ

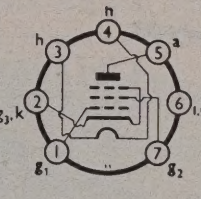
Base B9A

Output and bias oscillator
N727/6AQ5 or N78



V_h	6.3V
I_h	0.45A
V_a	250V
V_{g2}	250V
I_k	50mA
V_{g1}	−12.5V
P_{out}	4.5W

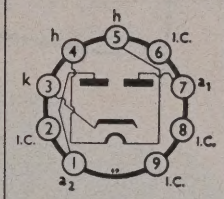
Base B7G



V_h	6.3V
I_h	0.64A
V_a	250V
V_{g2}	250V
I_k	40 mA
V_{g1}	−5V
P_{out}	4W

Base B7G

Rectifier
U709
full-wave rectifier



V_h	6.3V
I_h	0.95A
$V_{h\text{-}k}$	450V (max.)
V_{in}	350 rms (max.)
I_{out}	150 mA

Base B9A

The heater-cathode rating of the U709 permits operation from a common 6.3V heater winding

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Laboratory Notes

from BEACON RADIO LTD.

No. 25

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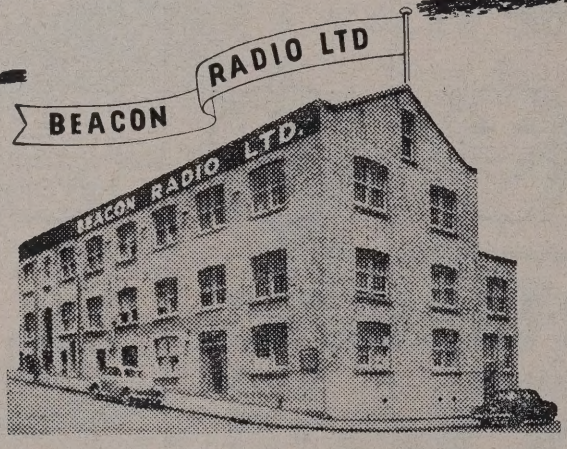
50A05 Mic. to Grid wide range, isocore can.
50A06 Mic. to Line wide range, isocore can.
50A07 Line to Grid wide range, isocore can.
53A12 Mic. to Grid wide range, isocore can.
53A13 Mic. to Line wide range, shielded, plug in octal base.
53A14 Line to Grid wide range, shielded, plug in octal base.



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RADIOCORDER

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Radio: 7-valve R.P.
Consumption: 80 VA with motor running.
Tape Speed: 7½ in. and 3¾ in. per second.
Playing Time: Half-hour and one hour on 7 in. spools.
Frequency Range: 60-8500 cycles.
Monitoring: Neon or earphones.
Power Output: 4 watts.
Erasure: High frequency.
Public Address System.
Speaker: Rola 6-9L oval.
Control: Hand or foot.
Fast forward; fast rewind.
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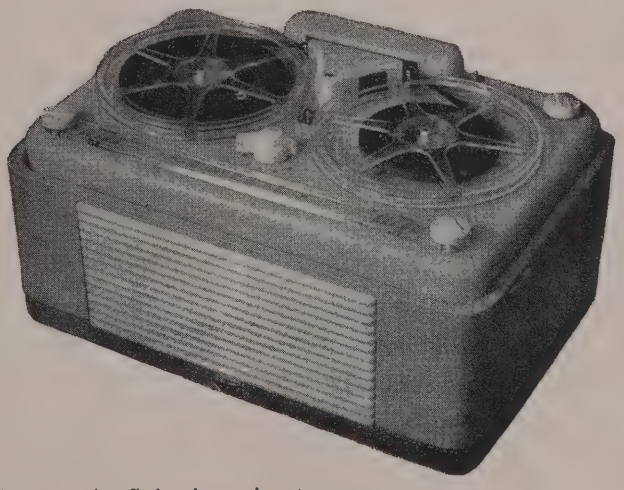

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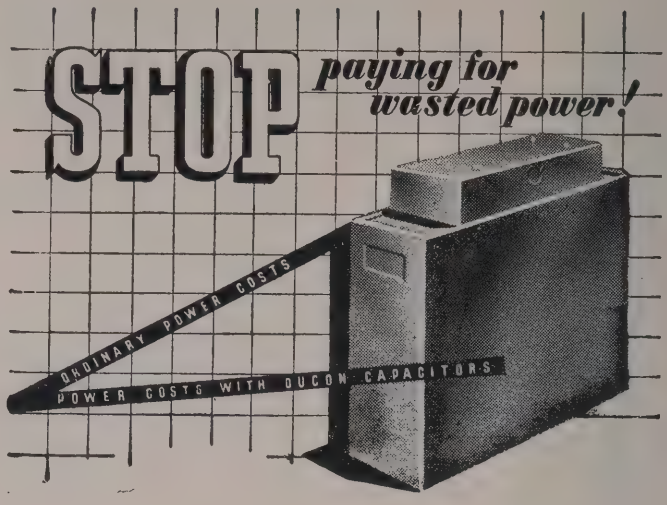

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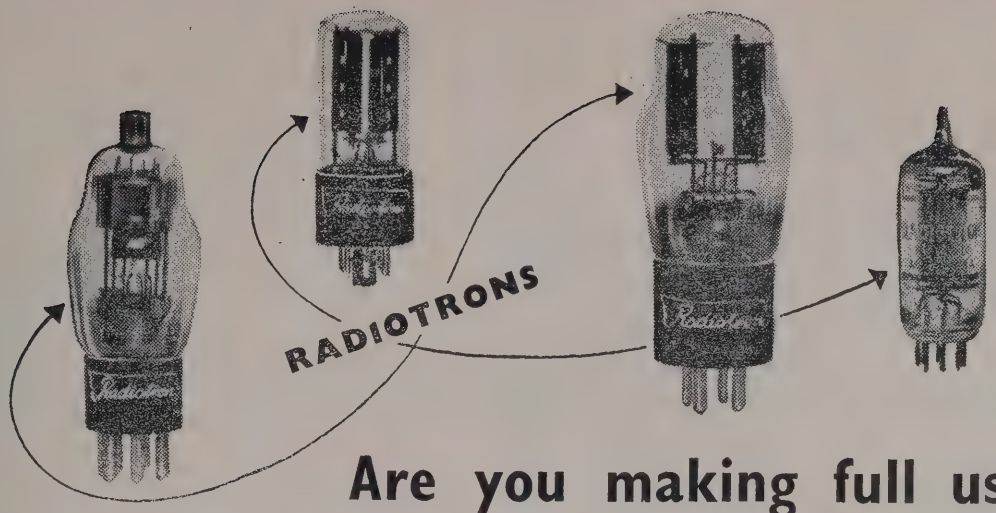

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THE NATIONAL NEECO ELECTRICAL AND ENGINEERING COMPANY LIMITED

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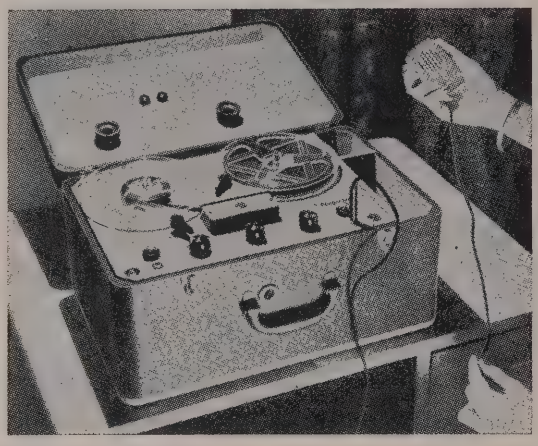
AWA *Magictape* RECORDER



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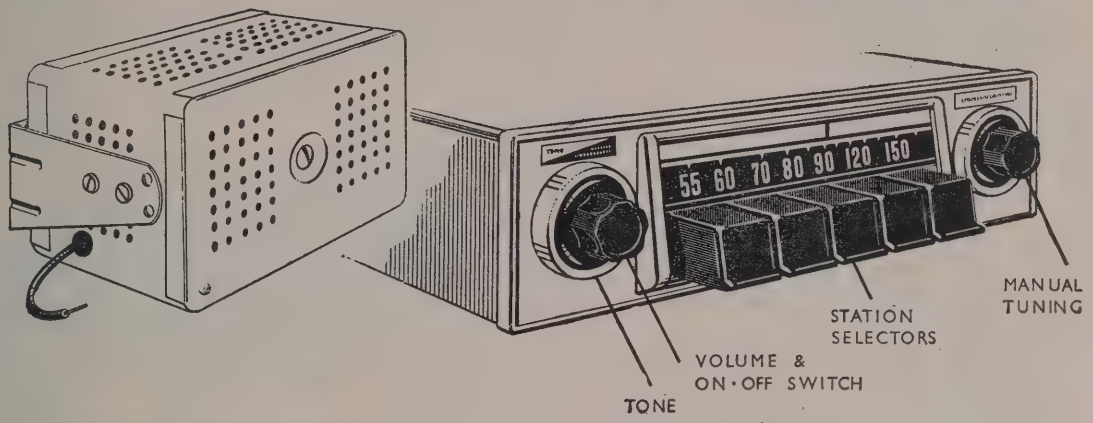

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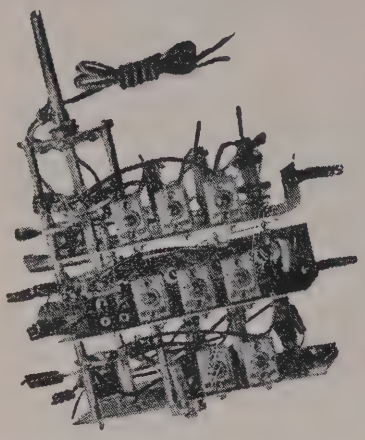

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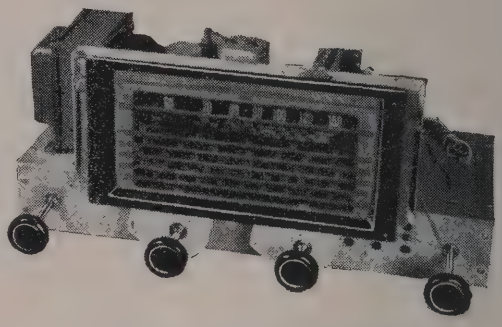

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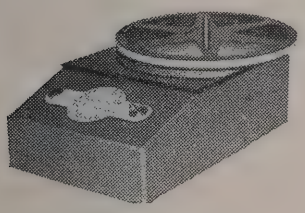

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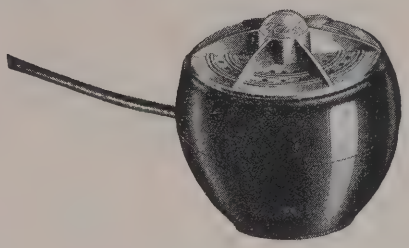

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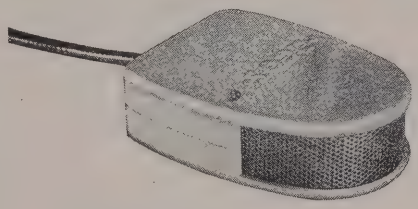

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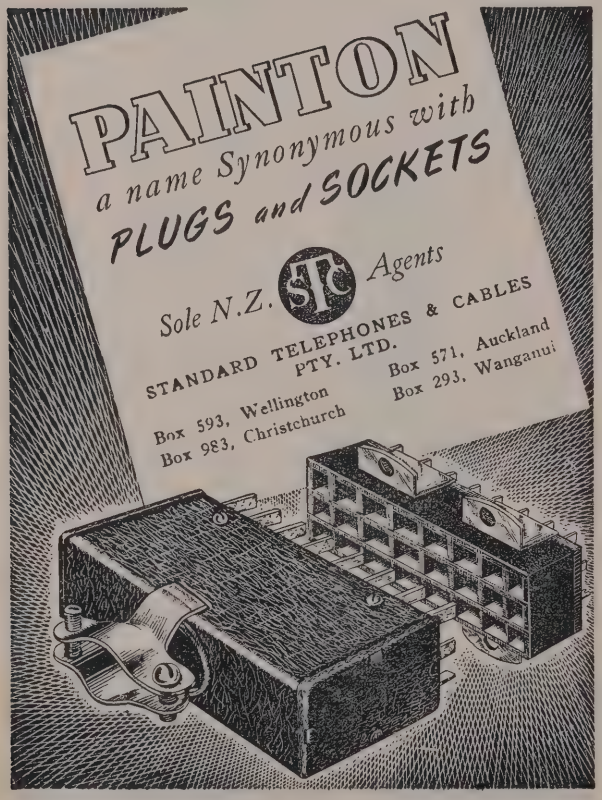

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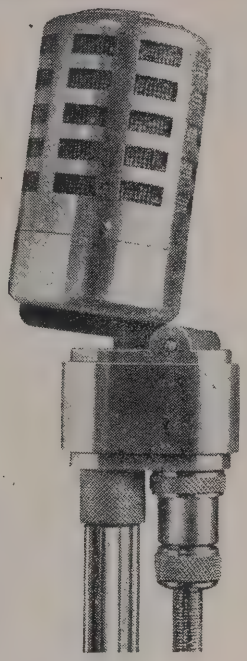

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Those whose business it is to sell gramophone records know only too well how great is present-day interest in recorded music compared, say, with ten years ago, and it is our belief that a significant proportion of it has arisen as a direct result of the recent achievements of audio engineering as a whole. While it is true that almost every link in the chain of reproduction, from microphone to loudspeaker, has undergone continual development and improvement over a long period, it is perhaps not too much to say that the bulk of the responsibility must be credited to the development of long-playing records, pick-ups that will do them justice, and tape recording. The subject is to some extent a debatable one, but this is how we see it. By itself, the mere fact that a long-playing record lives up to its name and plays for a long time could not account for the remarkable up-surge in public interest. Had the quality of L/P records as a class been no better than the best 78 r.p.m. discs, their obvious advantages for the presentation of serious music would undoubtedly have given them a following. After all, there were plenty of people with large record libraries before ever a long-playing record was on public sale, and it is hardly to be denied that many gramophiles would have swung over to L/P records even if they had not instituted a rapid and easily discernible improvement in the quality of musical recording. In our opinion, however, the L/P record has done much more than that. It has helped to create a new generation of gramophone devotees, many of whom would no more buy a 78 r.p.m. record than play their latest symphony on a portable gramophone! The L/P disc has done even more, with the aid of the excellent pick-ups which it has engendered. It has created, almost single-handed, a great demand for high-quality reproduction. That is why we are talking not only of those with technical leanings, but of many people with no interest at all in the mechanics of the business, for public awareness of high-quality reproduction has increased with the demand for recordings.

This awareness has been reflected in an increased demand for radio-gramophones—not only of the inexpensive type, but of the high-priced kind, and manufacturers' activity in bringing out new radio-gram. models has, in turn, reflected the industry's realization of the new kind of demand that has arisen. Now, we would be on rather delicate ground if we were to enter the controversy about whether the public gets the quality it is entitled to expect when it pays £100 and more for a commercial radio-gramophone. Be that as it may, the fact remains that there are many who are not satisfied with the quality of reproduction obtainable from stock models, and who want something better. Perhaps they have heard some custom-built installation, or an outfit that has been built up by the owner at considerable cost in not only £ s. d., but in hard work and experience as well. "What I want," they say to themselves, "is something like that." Unfortunately, wanting "something like that," and getting it, are two very different things, and the average music-lover usually has little or no idea of how to go about it.

Only too often, inquiry of the fortunate owner of the gear whose sound has been so much admired does little more than elicit the fact that he has spent perhaps two or three hundred pounds before getting it to its present pitch of perfection, and the unfortunate music-lover is discouraged, thinking, quite wrongly, that this must be a rich man's hobby, and that his old five-valve radio, with an indifferent pick-up attached, will have to do after all. Alternatively, he finds himself only too often in the hands of an enthusiastic amateur who is keen to help, and proceeds to do so, with results that are not always of the happiest. Not that many amateurs are not better at the job than some professionals—they are—but enthusiasm cannot always correct for deficiencies in the ability to design an audio system, nor can it compensate a disappointed "customer." What, then, is this unfortunate to do? About all he can do is to put himself in the hands of a reputable dealer who specializes in selling good audio equipment and seek his advice on what to buy. Fortunately, such dealers are becoming more numerous, but there is still a gap. The would-be purchaser may feel averse to taking advice from someone who is interested in selling equipment, and, in any case, proprietary makes of amplifiers are inclined to be very expensive, so that the man who wants to outfit himself as well as possible with a minimum monetary outlay is little better off. The point at issue is, can anything be done about it?

We think there can, and, what is more, we are going to try. Briefly, the idea is to give a short series of lectures on the subject, for the especial benefit of recorded music enthusiasts. We would particularly emphasize that the lectures are not to be technical ones. They will set out to explain to the music-lover why it is that special equipment is needed if the best results are to be obtained; how such equipment differs from standard commercial practice, and why; what equipment is essential, and what can be done without; the economics of the problem—can the desired result be obtained using relatively inexpensive equipment? What is to be gained by using very highly priced equipment? And so on.

Readers will notice that we have said nothing about the detailed design for the equipment, for that is a technical matter purely and simply, and our object will be to assist the non-technical devotee rather than the technically wise, who know all the answers in advance. However, we have a plum or two for the technically inclined as well. The lectures will be supported by demonstration of most of the points raised in the course of the lectures, and we expect to have an exceedingly interesting array of equipment to show those who attend. Without giving away any secrets we can say that we expect to be able to demonstrate gear that many will have little chance of hearing in the ordinary course of events, as well as showing how well (or how badly) good, but less pretentious, gear performs in direct competition with some of the best that can be had. A very full programme has been arranged, which we hope will prove not only instructive but enjoyable to all lovers of recorded music.

The lecture-demonstrations will be given by Mr. W. D. Foster, B.Sc., Editor of this journal, in the Lecture Hall, Wellington Public Library, Mercer Street, at 7.30 p.m. on Saturdays, 14th May, 21st May, and 28th May. The inclusive fee for the complete series will be 15s., payable in advance to Radio and Electronics (N.Z.) Ltd., P.O. Box 8022, Wellington. As seating accommodation is limited, those wishing to attend are advised to remit their fee as soon as possible. Any moneys received after the seating capacity of the hall has been filled will be returned immediately.

Instruments

AN AUDIO FREQUENCY OUTPUT METER

This article describes an inexpensive and easily-built output meter that will be found indispensable by many workers with audio equipment.

INTRODUCTION

The audio power output meter is an instrument of the greatest possible usefulness in any place where audio amplifiers are used or constructed, and indeed should be found on the bench of every radio serviceman. Unfortunately, however, it is not nearly as common as it should be, and its usefulness does not seem to be fully realized by many of those who could expect to benefit most from its application! In part, this situation is due to the lack of suitably priced output meters. Not many can afford to have the excellent one put out by General Radio, and about the only thing that comes to mind as a possible candidate for the service bench is that kind of multi-meter which has a decibel scale on it as well as voltages. Unfortunately, such meters can hardly be called output meters, for reasons which should become sufficiently apparent in the course of our argument. They do not give any direct indication of power at all, and are almost useless unless one is making measurements across a 600-ohm load. which is what they are usually calibrated for, with 0 db. marked at a level of 50 mw., or some other convenient figure.

REQUIREMENTS OF AN OUTPUT METER

What, then, are the requirements for an audio output meter? First, it must be able to indicate the actual power delivered to the load by an amplifier or radio set, on a direct-reading scale or scales. Secondly, it should have a decibel scale, with a zero marked at some suitable power level, so that it can also be used for taking frequency response curves. Third, it should preferably have load resistors built into it, corresponding in resistance to the most commonly used speaker impedances. It then becomes possible to test amplifiers on resistive loads, thereby eliminating the effect on power reading of speakers, which may have identical nominal impedances, but widely differing ones in practice, at the test frequencies. In addition, it should be possible to take power measurements while the amplifier is delivering power to a speaker load, because this procedure acts as a check on the speaker or speakers that may be connected at any one time. Such a facility may be very important when one is dealing with sound distribution systems in which a large number of different speakers can be used at different times, with or without dummy load resistors being inserted into the circuit to simulate the impedance of the speakers that are off for the time being. In addition, the use of external load resistors enables measurements to be taken at power levels which would be too high for load resistors of a size to be conveniently built into the meter itself.

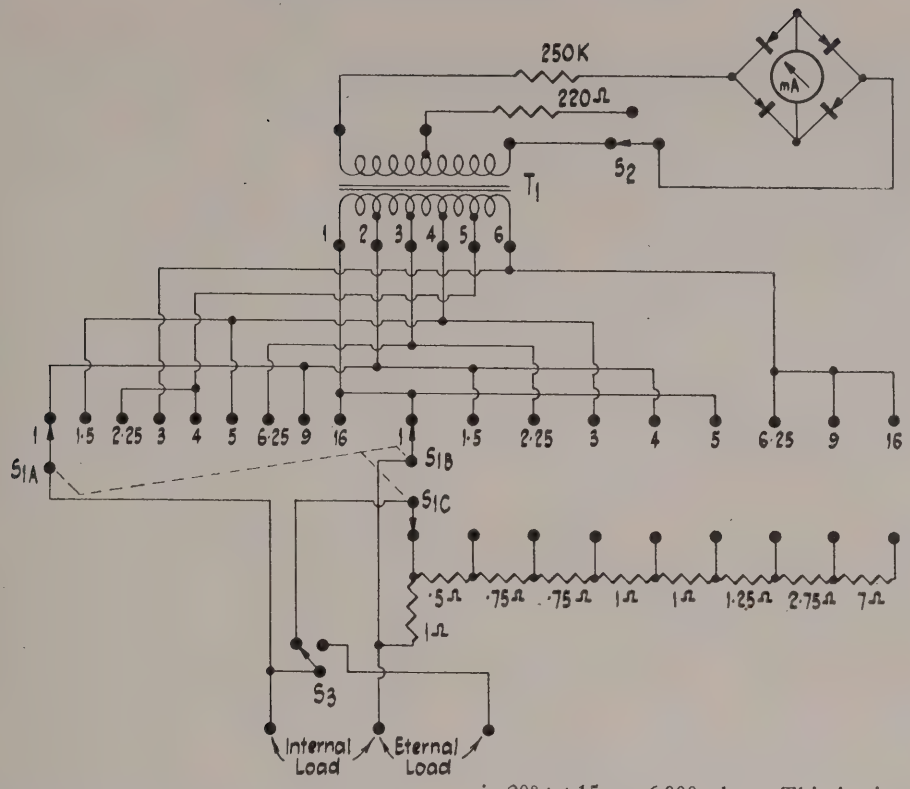
This list is not complete, but does serve to indicate the sort of instrument we are in need of for the purpose in hand. Other requirements, such as an indicator which does not show frequency discrimination effects between the frequencies of 50 and 10,000 c/sec., are easily complied with without affecting anything but the actual metering circuit. However, before such an instrument can be designed, it is necessary to decide what load resistances would be most convenient to provide, and what values would be most useful. Similarly, the question of meter scale must be investigated, and a decision made on the power range it is most useful to incorporate. If possible, too, the meter should have only a single power scale, which can be extended by the use of multiplying factors. Luckily, some of these questions settle themselves, and others are quite easily provided for, so that the design we are about to describe fulfils all the above requirements, and in addition, is inexpensive and easy to construct.

PRINCIPLE OF OPERATION

Unless one is going to use a watt-meter, which measures voltage across, and current through a load, and automatically calculates the power from them, there are only two ways of measuring the power output of an amplifier. The first requirement is that it should deliver its power to a known load resistance. Knowing this, we can then measure either the current in the load resistor, or the voltage across it. Then, by calculation from the well-known formula, the power can be found. The ammeter or voltmeter used can then be calibrated in terms of power. This is very simple and straight-forward where we have only one load resistance, but introduces complications when we have to take power measurements in a number of different load resistances. For example, suppose we have 16 watts of audio power being dissipated in a 16-ohm load. The voltage across the load would be 16v. R.M.S. But if the same 16 watts were dissipated in a 4-ohm load, the voltage would be only 8v. R.M.S. We would expect therefore, that the voltmeter built into the instrument would need a different sensitivity for each load resistor it was intended to use, or alternatively, a different scale for each load resistance, if the meter sensitivity were left unchanged. Although such an arrangement would be quite possible, it would hardly be very practical, as we would have either a large number of multiplifier resistors, each of which would need critical adjustment, or else an impossible number of scales, which would make the meter very difficult to read, even if it were possible to find room for them on its face.

There is yet another solution, and that is to use a step-up transformer from the load resistor to the voltmeter. If this is done, and if we are free to choose different step-up ratios for each load resistance, it will be possible to have only one scale on the meter. To do this, the switch which selects the desired load resistor would also have to select the correct transformer step-up ratio for it.

In principle, this is all very easy and convenient, but on the face of things, it would appear that a specially designed transformer would be needed. Not only would its frequency response have to be flat over the whole audio range, but it would have to have exactly the right ratios for the load resistances



Circuit of the complete instrument. The meter is a 0 — 1 ma. movement, connected with a standard meter rectifier to make it read alternating voltage.

that are chosen. A little thought, however, shows that the designers of multi-match output transformers have solved the problem for us. Let us see how this comes about.

If we look at the plate circuit of an output valve, we find that irrespective of the load resistance to which it must deliver power, the valve cannot have more than a certain value of A.C. signal voltage at its plate. In fact, the peak audio voltage must be somewhat less than the H.T. supply voltage if the waveform is to remain undistorted. For example, a valve with a supply voltage of 250 cannot have more than about 150 to 175 volts peak audio voltage at the plate. If there is more, the negative peaks will be flattened off, since the tube will be running into grid current, or into the region where the characteristic curves become crowded together instead of being evenly spaced. Thus, one way of regarding the job which the output transformer has to do, is to look at it as a step-down transformer which ensures that for a given load resistance, the peak signal voltage on the plate side is always the same. The exact transformer ratio will depend on the valve and on the load resistance at the secondary. But once the ratio is settled for any one load impedance, then the ratios required for any other impedance will be very easily found. Let us take the case of a hypothetical output transformer, which needs a turns ratio of 20 to 1 in order to match the valve to a 15-ohm load. The first thing we can work out from this is that the load required by the valve at its plate, is $20^2 \times 15$, or 6,000 ohms. This is simply an application of the well-known fact that in any transformer, the impedance ratio is the square of the turns ratio. In this case, whatever impedance we connect across the secondary will be "transformed" at the primary into an impedance of 400 times the impedance across the secondary. Now, if the valve is able to produce a power of, say, 5 watts, the R.M.S. voltage across the primary will be 173v. and that across the secondary will be 8.65v. If now we want to use a speaker with an impedance of 4 ohms, the transformer ratio must be altered so that when there are 173v. R.M.S. across the primary, the voltage across the loaded secondary is 4.48v. The step-down ratio must therefore be increased from 20 to 1, to 38.8 to 1. This can be done by placing a tap at the appropriate point on the original secondary.

Now let us look at this sort of transformer, used in reverse. If the secondary is tapped so that a constant voltage across the primary is transformed in the way illustrated above, to suit a number of different load impedances, it can obviously be used the other way about. For example, if the transformer secondary connections are used in such a way that the same winding sections are used across the load resistors as when the transformer is used in the ordinary way, we will find that when the power in the load resistors is the same, **we will always have the same voltage appearing across the terminals of the primary winding.**

The output meter therefore consists of a multi-match output transformer, used backwards, in order to step up the voltage across each load resistor, so that irrespective of load resistance, the output voltage for a given power dissipated in the resistor is

always the same. In this way, we are able to have a single voltmeter scale, as long as the switch which selects the load resistors also selects the correct step-up ratio. All the switching and wiring does is to change the load resistor and the step-up ratio of the transformer simultaneously. In order to simplify the instrument, a straight-forward rectifier-type meter is used, making the whole thing self-contained, and needing no power supply of any sort.

CHOICE OF VALUES

On the complete circuit diagram can be seen the values of load resistance that have been chosen. They are, 1, 1.5, 2.25, 3, 4, 5, 6.25, 9, and 16 ohms, and at first sight these figures may seem a trifle peculiar. Why, for example, are the two highest ones not 8 and 15? If they were, they would correspond exactly with two popular values of speaker impedance. The reason is to be found in the fact that a stock type of multi-match output transformer was used, and not one specifically designed for the job. This being the case, we are not free to choose the tapping points on the secondary of the transformer. In point of fact, the ratios between the numbers of turns in the various sections of the winding are such that if we choose 16 ohms as the highest load resistance, **the values shown are the ones that are correct for the ratios actually provided by the transformer.** Why, one might well ask, has the maker of the transformer not made the ratios in such a way that if the highest load were 15 ohms, the remaining ones would be right for 8 ohms, and other values, such as 2½ ohms, which are the nominal impedances of numerous stock loud-speakers? The answer is that as the transformer stands, the ratios are nice round numbers that are easy to count, and which must make the correct counting of numbers of turns very much easier when the transformers are being made. As well, the practical significance of using a transformer on a 15 ohm speaker, when the ratio says it should be correct for a 16 ohm one, is nil. In other words, the difference between using the exact matching ratio and the ones provided is so slight that no one could ever tell the difference except by using instruments and very careful measuring technique. For our purpose, however, there would be a significant difference, if we were to use load resistors different in value from the ones which correspond exactly with the actual transformer ratios. Thus, the figures we have quoted are the actual values of the load resistors that have been built into the instrument. If this were not done, we would find that equal powers into different load resistors would **not** give the same meter reading, and this must be avoided at all costs. It is true that this will cause us to use the actual load resistors that do not have the exact value of the speaker impedance in all cases, but the error caused by so doing is so small as to be negligible. For example an amplifier that has an output transformer arranged to match it to a 15 ohm speaker will have to be tested with an actual resistive load of 16 ohms, but in view of the fact that the nominal impedance of a speaker is seldom very similar to a resistive load of the same value in any case, a small discrepancy like this will not be noticeable. The thing to do when testing an amplifier is to use the load resistance which is nearest to the nominal impedance of the speaker which the amplifier is arranged to match.

MEASURED POWER RANGE

Another major point that must be decided is the range of powers over which the meter is supposed to work. Fortunately, this is not at all difficult to decide, because the scale is not a linear one, and therefore provides a wider range of readings than would otherwise be the case. Remembering that the meter knows nothing about power, but can measure voltage only, we see from the formula that $P = E^2/R$. Thus the power read is proportional to the square of the voltage reading. Let us see just what sort of scale this gives us. If the full-scale reading represents, say, 16 watts, a half scale reading will represent not 8 watts, but 4. Similarly, a quarter-scale reading will indicate 1 watt, and an eighth scale will read 250 mw. From this it can be seen that one scale can accommodate both small and large powers. In our own case, we have chosen to make full scale equal to 16 watts, so that the meter covers the range of powers most often encountered in amplifier work. However, there is sometimes a need for measuring greater powers than this, and fortunately, there is a very simple way of doing this. The multi-match transformer used to set up the voltage for the meter has a centre-tapped primary. If we put in a switch which connects the meter across one half of the winding, then the reading will drop, although we have not changed the power delivered by the amplifier under test. The deflection will be exactly one half the previous figure, and the needle will indicate one quarter the power, so with the switch in this position, the power is the indicated value, multiplied by a factor of four. In this simple way, the scale is extended up to powers in excess of 50 watts, and the full-scale reading will be 64 watts. There is only one difficulty about this extension process. The built-in load resistors are unlikely to be able to stand 64 watts being passed through them, without becoming red hot, so that for the higher powers it would be advisable to use an external load resistor, capable of dissipating the required power. The feature does, however, make the instrument an exceedingly versatile one.

COMPLETE CIRCUIT

As can be seen from the diagram, the instrument does not contain many parts. There are the meter, its rectifier, the transformer, a three-pole nine position selector switch, and two simple change-over switches. Finally (and these represent the worst job of manufacturing the instrument oneself) there are the load resistors. The wiring looks a lot worse than it really is, because a large proportion of it simply consists of inter-connections between points on the switch. The numbers marked against the six secondary connections correspond with the maker's own numbering of these lugs. If the wiring is traced, it will be found that on the 1 ohm position, transformer lugs 2 and 1 are shunted across the 1 ohm load resistor at the bottom of the chain. In the 1.5 ohm position, S_{1c} selects the 1 and 0.5 ohm resistors in series, while S_{1a} and S_{1b} connect transformer terminals 2 and 4 across the load. So things go on, until on the 16 ohm position, all the resistors in series are used, and the whole transformer secondary is used too.

S_3 is the switch which selects the internal load resistors, or an external one. Note that on External Load, S_{1a} and S_{1b} still function, so that the external

load used must have the same impedance as one of the internal loads, and also, the selector switch must still be set to the appropriate tap for that load. One trick that can be done with this arrangement is to connect the speaker to the external load terminals, and the amplifier output to the internal load terminals, whereupon switching over to "Ext." with S_3 disconnects the dummy load, and substitutes the speaker, while the meter continues to read. Thus, any great change in power reading indicates that the speaker impedance at the test frequency does not correspond closely with the load resistance chosen for test.

MAKING THE LOAD RESISTORS

Unfortunately, it is not possible to buy stock resistors of the values needed for the dummy loads, and these have to be made up by the individual constructor. Fortunately, the job is not difficult—only tedious—and it can be done with a minimum of equipment. The best thing to make the resistors from is nichrome wire of any suitable gauge—say 20 to 24 S.W.G. The largest single resistor to be made is only 7 ohms, and even in the comparatively thick gauges mentioned, 7 ohms will not represent a very great length. The best plan is to obtain a piece of paxolin board about 3 in. x 4 in., and rivet or bolt to this a number of solder lugs, spaced by about one inch intervals. The correct lengths of wire are then wound round suitable formers to make them into small coils, which are removed from the formers and soldered between the appropriate lugs. The best method of construction is to use fairly heavy bolts, with solder lugs on both sides of the sheet of paxolin. On one side of the sheet the resistors are soldered, and on the other are connected the switch leads. This method prevents the PVC-covered leads from becoming too hot if the resistors heat up considerably, as they are likely to do when the power is left on for protracted periods. Actually, unless a large amount of power is fed for some time to one of the lower load resistances, the power loading on the individual resistors is not very great. This is one reason for using the sum of a large number of resistors in series, to make up the higher values, rather than make separate resistors for each value of load. If no measuring gear is available, it is still possible to make the load resistors with reasonable accuracy by finding out the resistance of the wire used, in ohms per foot. This is measured by the makers as each reel of wire is filled, and the information is placed on the reel. Finding the figure then becomes only a matter of asking the shop assistant to read it from the reel. However, should this information not be forthcoming, the best plan is to buy enough wire for the job, and then find someone who can measure low resistances accurately on a bridge. If a length making up some round figure such as ten ohms is accurately measured for length, then it is a simple matter to work out the resistance per foot. When this is known, the resistors can be made up simply by measuring out the appropriate lengths of wire.

Alternatively to this scheme, one can use the O — 1 ma. meter that is to be incorporated in the completed instrument. With a known source of voltage, such as an accumulator, which gives a steady 2 volts for the greater part of its discharge, it is possible to measure the current through a piece of the wire, of known length, and again calculate its resistance. This job is rather easier if the milliameter reads 0 — 100 ma..., instead of 0 — 1 ma., since only a tenth of the resistance is necessary to give full scale deflection on the meter. For the benefit of intending constructors, we might mention that one make of nichrome wire measures 0.511 ohms per foot at ordinary temperatures for 20 gauge, and 1.37 ohms per foot for 24 gauge. Both gauges mentioned are S.W.G.

The meter is a 0.1 ma. movement, and the rectifier is a standard meter rectifier, of the sort that is readily available in many parts dealers'. Readers will note that we have put in the value of multiplier resistor that was used in the original model, but that this is not necessarily the correct value if a different meter movement is used. The right values should be found by experiment, in the following way. First, an amplifier is used to put either four or sixteen watts into any one of the load resistors. This can be measured by means of any external meter that will accurately measure A.C. voltages at a frequency of 1000 c/sec. or so. If sixteen watts is used, the voltage across a 16 ohm load will be 16 volts, and when the external meter has been used to set the output at this level, the multiplier resistor should be adjusted until the meter reads full scale. However, four watts is easier to obtain, and this can be measured by the calibrating meter as 4 volts across 4 ohms, or 8 volts across 16 ohms. In this case, the multiplier resistor should be chosen to give half scale reading on the output meter.

On the circuit, S_2 is the range switch, and it will be noted that a 220 ohm resistor is shown in series with the centre tap. This is included in order to replace the D.C. resistance of the half-winding which has been switched out of circuit. Its value is so small, however, that it is doubtful whether such correction is necessary.

LOADING BY THE METER CIRCUIT

At first sight it might appear that connecting the low-impedance winding of an output transformer across the load resistor, which is itself fed from a low-impedance transformer winding, might upset the output circuit of the amplifier, but a little thought will show that this is impossible. It is frequently forgotten that a transformer winding does not of itself present any sort of loading to a device to which it is connected. Even a winding of a few turns on a closed iron core has a very high impedance, and so makes no difference at all if the transformer is shunted across a low impedance, such as we are dealing with at the output of an amplifier. However, if a certain impedance is connected across one winding, this is transformed into a different impedance, which appears at the terminals of the other winding, and has exactly the same effect as if the reflected impedance were actually there itself, without the interposition of a transformer. Taking our meter transformer as an example of this, we have a resistor of 250k. connected across the primary winding. The step-down ratio of the primary to the whole of the secondary terminals are connected to a circuit, the secondary treminals are connected to a circuit, the effect on that circuit will be the same as if instead, we had connected a resistor equal in value to 250k. divided by the impedance ratio of the transformer. This, as we have seen, is 20^2, or 400:1, so that in

(Continued on page 50).

Audio

THE "ULTRA-LINEAR" OUTPUT STAGE

IS THERE ANYTHING IN IT?

Some time ago now, the claim was made in America that a new arrangement, which was called the "ultra-linear" output stage, was capable of providing **simultaneously,** all the advantages that had been claimed for triodes and tetrodes. At first sight, this seemed somewhat of a tall story, because, as Williamson, of amplifier fame, lost no time in pointing out in the pages of "Wireless World," the new technique was clearly a case in which the valves were operated in a condition part-way between triode and tetrode conditions. This being so, it was argued, how can any intermediate sort of operation have advantages not possessed by either type of valve? This argument still looks as well-founded as when it was first produced, but there must be more in the question than meets the eye, if we are to believe experimental results which have been published by the General Electric Co. of England. These results bear out the original claims made for the circuit, but the authors of the report make no attempt at an explanation. However, the results themselves are sufficiently interesting for us to reproduce here for the benefit of readers who may not have seen the original. First of all, though, some explanation of what the new circuit is should be given.

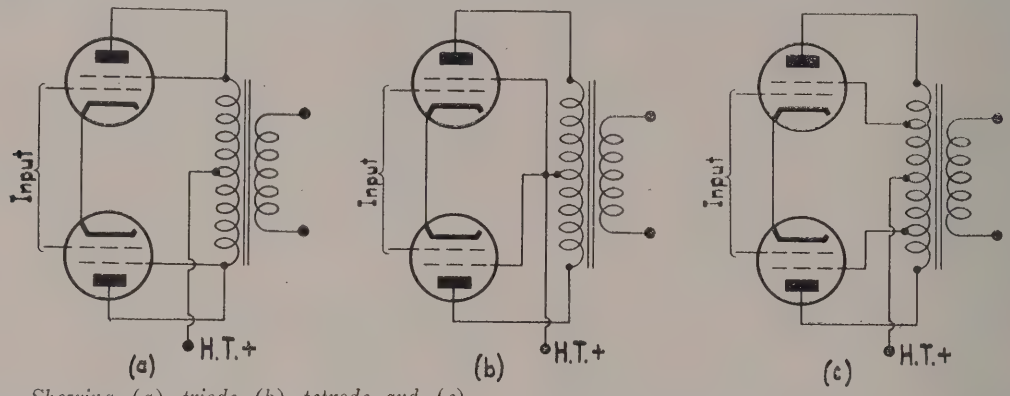


Fig. 1.—Showing (a) triode (b) tetrode and (c) ultra-linear (or Triode-Tetrode) connection of output valves.

WHAT IS THE ULTRA-LINEAR CIRCUIT?

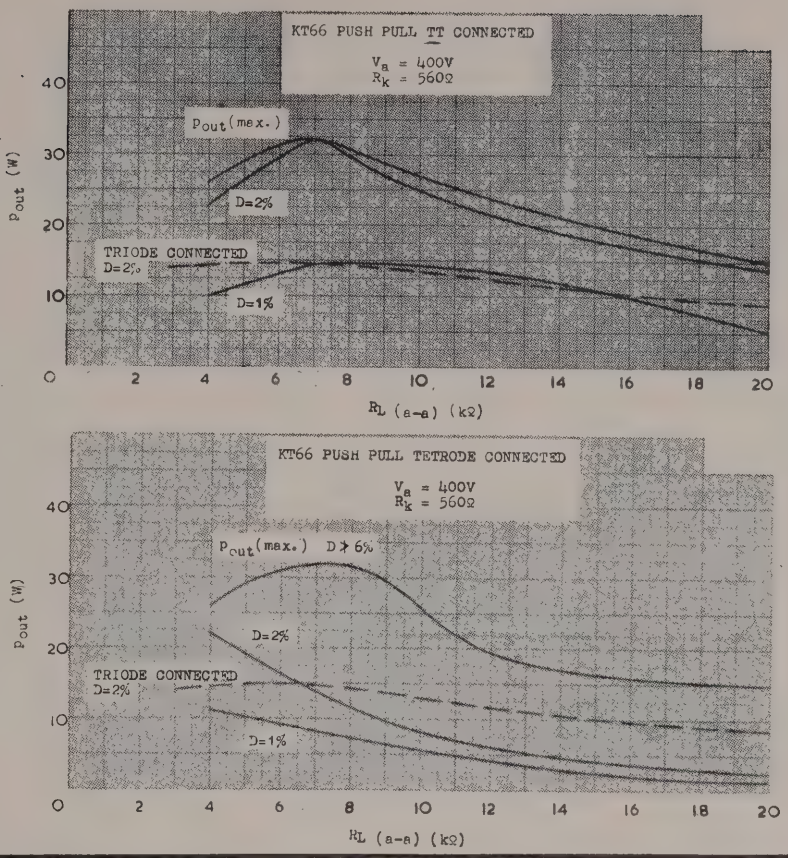
In the first place, it is of interest to note that the idea was not (repeat NOT) originated in the U.S.A., but was another of the many original contributions to circuit design of the late A. D. Blumlein, as the British Patent Office records can prove. When we take a pair of triode-connected tetrodes, and place them in an ordinary push-pull circuit, we have the arrangement of Fig. 1 (a). If we connect the same valves as tetrodes, the circuit is that shown in Fig. 1 (b). Here, the plates only have their potential varied at an audio rate, and the screens are provided with a pure direct voltage. In Fig. 1 (a) the screens are at the same potential as the plates, and so have audio voltages superimposed on their steady D.C. potentials. The ultra-linear circuit is shown at Fig. 1 (c), and it can be seen that the screens are tapped out from the centre of the transformer primary, so that they still have the same D.C. potential as in the other two cases, but a different A.C. voltage is superimposed upon it. The exact amount depends on the distance out from the centre at which the points of attachment for the screens are situated. It is not difficult to see now where Williamson's argument comes in. With tetrode operation, we get high plate efficiency, with critical adjustment of output load resistance if the distortion is to be kept low up to large power outputs. The distortion, however, is somewhat greater than can be had from the same valves as triodes, working to give the same power output. This is the reason why triodes are so often preferred when it comes to designing high-quality amplifiers. The protagonists of the ultra-linear circuit claimed that it gives more undistorted power output than the triodes, and the same high efficiency of the tetrodes, so that virtually, we are both having our cake and eating it too! Alternatively the new connection will give the same power output as the triode connection, but with a good deal less distortion.

Being naturally suspicious of the claims made in some quarters, we ourselves tended to side with Williamson in the matter, and in consequence have not yet carried out any tests of our own. It was with some surprise that we noted the practical results obtained by the originators of the much-revered KT66! The curves they obtained are reproduced here, and show power output against plate-to-plate load resistance, for given quantities of total distortion. In each case, the curve for 2% total distortion from the triode-connected tubes is used for comparison purposes. The most astonishing thing about these results is that they show the TT (Triode-Tetrode) circuit, as the G.E.C. people have called it in preference to its trans-atlantic title, to give approximately twice the power output for a given total distortion, of the triode circuit, while other figures show that the plate efficiency is almost double that of the triode circuit at full output,

WHY?

As to that, we would rather not commit ourselves. It does appear, however, that the circuit does not behave according to the "common-sense" view, as propounded by Williamson. There must be more to it than that, and at the moment, what the unknown factor might be is anyone's guess. Suffice to say at the moment that there is somthing well worth investigating.

On the other hand, no one has yet claimed, apart from our American friends, that the TT circuit is best only when plate efficiency, or large power output from a given pair of valves is the most important factor. Should this be so, we will be back where we started, because it is generally agreed that such is the case as between triodes and tetrodes.



NEWS FROM GOVERNMENT DEPARTMENTS

CIVIL AVIATION:

V.H.F. Radio for Control of Air Traffic

Considerable increases in efficiency and safety will result from the introduction of V.H.F. radio for the control of air traffic in New Zealand.

Planned by the Civil Aviation Administration, and using four stations situated in the Waitakeres, on Mt. Egmont, Colonial Knob and Banks Peninsula, the new V.H.F. network will provide instantaneous two-way communication between aircraft and air traffic control centres over the whole of the main trunk route from Dunedin to Auckland.

This network will replace ordinary high frequency radio communication, whereby messages have to be relayed from the aircraft's nearest aeronautical radio station to the control centre by radio or landline, a procedure which often entails a delay of between five and six minutes between request and reply.

Normally, using very high frequencies, it will not be necessary for transmissions to be read back by receiving stations, thus further reducing delay and enabling more efficient use to be made of the channels available.

Very high frequencies reduce the interference caused by stations beyond the line-of-sight range, and communications during bad weather are still reliable. Improved direction finding facilities provided for aircraft flying in poor visibility will further add to the safety of aircraft.

Owing to the restricted coverage of V.H.F. transmissions, more channels are available than for H.F., and a band has been allocated for aviation use which will cope with any air traffic expansion in the forseeable future. Such provision cannot be made with high frequencies.

The lighter airborne equipment required for V.H.F. communication is also an important consideration.

The first V.H.F. station was established 3,500 feet up on the eastern side of Mt. Egmont, and a second station, operating on the same frequencies, has been set up on the top of 1,500 feet high Colonial Knob, near Wellington. Between them, these two stations cover aircraft flying between Kaikoura in the south almost to Auckland in the north. The scheme will be completed by the erection of a station in the Waitakeres and on Banks Peninsula.

New control desks to be installed at the Wellington Air Traffic Control Centre will permit convenient operation of all communication channels used. The system will be capable of operating several air-ground channels, and by the end of December next two channels will be in operation. Thus, the capacity of the system to handle traffic will be doubled—a factor of considerable importance in view of the increasing number of aircraft now flying.

NEW ZEALAND POST OFFICE

Through an international film exchange operated by the Universal Postal Union, films on New Zealand Post Office methods were seen last year by Post Office authorities in France, Israel, Yugoslavia, Japan, Switzerland and the German Federal Republic.

This exchange system was initiated by New Zealand and has been widely used by postal administrations throughout the world since it was established five years ago.

* * *

There are 6,897 registered radio stations in New Zealand. These include broadcasting, amateur, research, ship, aircraft, Government, Post Office Stations, and private stations.

BINDERS FOR "R. & E."

These are available to hold 12 issues—price 5s. 6d.

TECHNICIANS IN SCIENTIFIC RESEARCH

Scientific research is now one of the biggest employers in the world, and is very short of staff. Anyone who has the right qualities can work in it if he wants to. It is still a growing industry, even in countries like the United States and Great Britain, where it is already big, and it is just starting in New Zealand. This is happening because modern industry has found that science pays.

Scientific research uses three grades of people—professionals, technicians and workshop staff. The professional plans experiments, controls the accuracy with which they are carried out, (sometimes does them himself), and decides, by a good deal of theoretical work, whether the results of the experiments answer the questions that the research was designed to settle. His importance is well known, but little or nothing is known by most people of the technician who is his right-hand man. The latter is skilled in the **practical** part of the science, often more skilled than the professional, and sometimes more skilled in a particular job than anyone else at all. He is always a specialist in a subject such as photometry or isotopes or mechanical vibratons, and the popular idea of a scientist as a man who can handle apparatus so well that it almost does miracles, is more often true these days of a technician than of a professional. It is commonplace for him to do things that have never been done before, and, in most large laboratories, scientific research would slow down enormously if he were not there.

People choose the jobs they do either to make money, or because they find them interesting. No one pretends that fortunes are made in scientific work, but scientific workers are notable for their very great interest in what they do. They are keen on reputation, on being treated well, on having enough money to live on, and in having the chance of doing congenial things in their spare time and holidays, but principally they think and live work. Obviously, it is not everyone who feels like this, so science is a job for some people and not for others. It need brains, so the unfortunates who can never get past the third form should leave it alone. The ruthless egotist should stick to business. The man who wants a job simply to support him while he enjoys an easy life of fishing or gardening or any other hobby should look elsewhere. What science wants is men interested in thinking, who want to find the answers to questions, who want to make something that works, to do things that no one else can do with apparatus or with calculations, to satisfy themselves with a job that is worth doing. None of this means that only Einsteins or Rutherfords should take up science. A great many things are being done for the first time every day, and it is very satisfying to be the man who does even a small thing for the first time. It is very satisfying too, to work and search, perhaps for a long time, for a fragment of knowledge that is not well-known, and to end by being quite certain of it. Both of these things form the basis of the reputation that a scientist builds up, and that is the way he satisfies his ambition. Some people who might be useful in scientific work do not take it up because they have not been interested in science as a subject at school. This is a mistake, because the scientific work being done today covers so much more ground than school science that you cannot think of it as a subject at all. Anyone who has the right sort of mind, who is interested in the things of which we have just been talking, will find a satisfying life in scientific work, probably in a subject that is not even heard of at school! To take a simple example; many people at school are interested in radio and might think of taking it up as a career. But, what they really want from radio quite often is satisfied by geophysics, nuclear or atomic physics, vibrations, acoustics, or the investigation of properties of matter, because these all use techniques derived from radio. Generally it is the technique rather than radio itself, which appeals to those at school where radio is usually not a scientific subject.

Already we have said, that in a scientific team, there are professionals, technicians and workshop people. About workshop people we need not talk here. The professional also, we can leave with very little comment. He must have a good science degree. Thus, on leaving school he will go to a university rather than look for a job immediately, and at school he must be near the top of his form. Our subject, the technician, is to be the right-hand man of the professional, so if any boy or girl at school is good enough for the university, he should not look for a job as a technician. The latter are drawn from those who have attained either the fifth or sixth form and feel that scientific work would be interesting. Certainly it could prove most interesting to many people who have not yet realized it.

Naturally, no one can walk into a big laboratory and perform all the jobs in hand. Therefore, at the Dominion Physical Laboratory, a technical trainee, the technician's name for the first few years, is given his first chance on something he can do already. He has the opportunity of working in different parts of the laboratory for a year or two to see where he fits best. In each section he commences with a simple job—usually helping an experienced technician. Such practice pays, for the trainee can thereby satisfy both the D.P.L. and himself by doing it well. Too difficult a job does not help the trainee and ends only in his doing it badly whereupon it has to be redone by someone else. In all D.P.L sections, the work must be done well to be of any use, and in some sections it must be done as well as humanly possible, which needs considerable practice. That is why the work of a technician can be so satisfying.

The subjects on which the Dominion Physical Laboratory is working include:

Making geophysical instruments, so that the structure of the country can be better understood, and geothermal power can be developed.

Acoustics for the purpose of designing buildings in which it is easier to hear, and to assist the early diagnosis of deafness.

The Ionosphere, to increase the reliability of radio communications between New Zealand and other parts of the world.

Doppler and phase coherent methods in radio, for the making of all sorts of measurements.

Metallurgy, to ascertain what parts of engines, frameworks, etc., break unexpectedly, and why.

New Zealand standards work on length, mass, volume, temperature, frequency, electrical quantities at D.C., 50 c/s., audio frequencies, and radio frequencies, to assist the comparison of New Zealand measurements with those made overseas.

Electron microscopy, to view very small objects and thus help understand the structure of teeth, the way a virus spreads, and so on.

Dating by radioactive carbon of ash showers at Taupo, of clay deposits at Rangitikei, and many other interesting things in the geological history of New Zealand.

Other nuclear physics devoted to the extension of atomic study in N.Z.

Mass spectroscopy, as a very refined form of chemical analysis.

The effect of earthquakes on buildings.

The improvement of the concrete used in big dams and other places.

The design and making of lenses and mirrors.

Photometry, to improve the efficiency of lighting.

REQUIRED QUALIFICATIONS

Prospective technical trainees should possess one of the following qualifications:—

School Certificate.

Endorsed School Certificate.

University Entrance.

SALARIES

For trainees holding a School Certificate the commencing salary is £255 p.a. plus 10%, for those holding an Endorsed School Certificate or a University Entrance, the commencing salary is £295 p.a. plus 10%.

These salaries proceed by annual increments to the maximum of £608 p.a. plus 10% for a Grade III technician. Thereafter promotion depends on ability, it being possible to attain grades with maxima of £680 p.a. and £740 p.a. (both plus 10%), in addition to which there is a grade commencing at £770 p.a. plus 10%. In 1953 the average Public Service technician's salary was £600 p.a. plus 10% at thirty years of age, and £650 p.a. plus 10% at thirty-two.

ADDITIONAL TRAINING

Most technical trainees attend evening classes at one of the local technical colleges. Success in a suitable course (supplemented by certain instruction and examinations at D.P.L.) lead to a Public Service Technician's Certificate, which will help promotion.

Though such cases are rare, it is not impossible for an exceptionally able technical trainee to be sent to the University as a full-time bursar.

GENERAL

Appointments are subject to the Public Service Act and Regulations, which, amongst other things, control annual leave, sick leave, superannuation, and the conditions of probation which lasts for two years.

Students, parents, vocational guidance officers, or career officers who wish to discuss the possibility of employment may obtain further details from the Director, Dominion Physical Laboratory, Lower Hutt.

LETTER TO THE EDITOR

Sir.—You may be interested in a simple idea for combining the decorative effect of a slide-rule dial with the fidelity of a switched, wide-band tuner.

This requires the provision of a wafer on the station selection switch, wired to dial lights. A conventional slide-rule dial is used, of the type in which the flood lighting normally shines through the station call-signs. The pointer assembly is removed and the whole of the area containing the call-signs is covered by an opaque material, in which holes are cut behind the call signs of the stations for which the tuner is used. Behind these spaces is placed a dial lamp which is wired to the appropriate contact on the wafer. The remainder of the dial (frequencies, decorations, etc.) is still illuminated by the normal side-lights.

Many variations of this scheme are possible, and not least among the advantages of the scheme are the removal of an unsightly "home-made" station indicator round the switch and the rare but pleasant experience of choosing the most artistic dial on the market without any fear of its not tracking.—I am, etc.,

JOHN M. STEIN, Auckland.

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The PHILIPS Experimenter

An advertisement of Philips Electrical Industries of N.Z., Ltd.

No. 90: PHILIPS TRANSISTORS (PART 5)

Reprints of these EXPERIMENTER articles, complete with illustrations, will be mailed to any address for one year for a subscription of 5s. Application should be made to Technical Publications Department, Philips Electrical Industries of New Zealand Ltd., P.O. Box 2097, Wellington.

The oscillator circuit we were describing in Part 4 of this series was intended specifically for the 80-metre amateur band, but is able to oscillate up to at least 7 mc/sec., and will lock easily to the crystal frequency when the tuned circuit is sufficiently close to that frequency. It will even oscillate on the second harmonic of the crystal, provided that the output frequency is not higher than 7 mc/sec.

As we mentioned earlier, the 3-30 $\mu\mu$f. trimmer across the emitter bias resistor has an important bearing on the working of the circuit at the (relatively speaking) high frequencies we are considering. Its adjustment affects both the output, and the ease with which the oscillation locks to the crystal frequency.

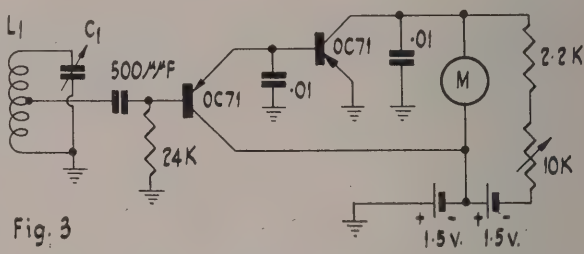


Fig. 3

Circuit of the absorption wavemeter L. C. to tune to any radio frequency.

ADJUSTMENT OF THE OSCILLATOR

In order to adjust the circuit properly, the main requirements are a meter in the collector circuit, and a receiver or beat frequency meter with which to listen to the note. For a start, set the trimmer at about half scale, and tune the oscillator circuit slowly. While this is being done, the H.T. should be keyed, and the note listened to. The note when the oscillation is not locked by the crystal is shocking, being affected by a slow frequency drift that is so slow that it can hardly be called a "chirp" at all. This change in frequency is due to the warming up of the transistor junctions as current is passed through them, and cannot be avoided by any means whatever, so that unless the oscillator is crystal-controlled, it will be almost useless as a transmitter. Luckily, there is no difficulty about the crystal locking. If the recommended procedure is carefuly carried out, a point on the tuning condenser will soon be found at which the note sudenly cleans up completely, and becomes a genuine crystal-controlled one. If the tuning is carried further it will be possible to observe the range of settings over which the locking persists, and initially, the tuning condenser can be set in the middle of this range. The next step is to adjust the 3-30 $\mu\mu$f. trimmer. Adjusting it over its complete range is not likely to put the oscillator out of action altogether, but it will affect the power developed, and the ease with which locking is obtained. It is not difficult, if some output indicating device is used, to find the setting of this control which gives the greatest output, and at the same time it will be seen that at this point, and when the tuning is set for greatest output also, we have maximum current in the collector circuit. Unfortunately, this is not the correct setting for operating the oscillator in. If everything is tuned up "on the nose," it will be found that sometimes the oscillator will start, locked in the proper way, but that at others it will be running self-controlled. This can be avoided by choosing the correct setting for the trimmer, or by detuning the tank condenser. Luckily, too, the trimmer setting has only a minor effect on the output over a great part of its range, and this part includes the proper setting, so that it is necessary only to adjust the trimmer so that when the tuning is set exactly, the oscillator never starts uncontrolled.

Loading the oscillator is not difficult. Of course, the power available is very minute, being derived from a D.C. collector input of between 2 and 3 ma. at 22½ volts when the circuit is unloaded. It has been possible, however, to load the oscillator up to a collector current of about 6 ma. and this should be possible without any great change in the settings of the controls. The method used for drawing off the output power is optional, as any of the conventional methods of output coupling may be used. In the circuit diagram we have shown a fixed link, which is intended to feed an aerial tuner, but this system is not essential. It is essential though, to take the greatest care with the tuning of the aerial and with the loading adjustments, so as to give the greatest possible aerial current. It is not suggested that this can be measured directly, but there is no reason why the usual techniques should not be used in the setting-up procedure. Measuring the power fed to the aerial, even on a comparative rather than an absolute basis can be difficult with such small powers as this, so that a sensitive absorption wavemeter is recommended as the best indicator of output. A very suitable circuit is the one which we are to describe next, and which uses a pair of Philips OC71 junction transistors to obtain exceedingly high sensitivity. Without any aerial other than its own coil, this absorption meter will give about half-scale deflection on a 0-500 amp. meter when the oscillator is not

loaded by an aerial, and is three feet or so away from the wavemeter!

COIL DATA

L_1 consists of 28 turns of 27-gauge enamelled wire, wound to a length of $1\frac{3}{8}$ in. on a $1\frac{1}{4}$ in. diameter former. The tap is 14 turns from either end. The output coupling link is a 5-turn winding interwound at the earthy end of L_1.

AN ULTRA-SENSITIVE ABSORPTION WAVEMETER

In Fig. 3 we have an interesting example of transistor circuitry that is ideally suited to a number of jobs in the amateur's shack. Its sensitivity is surprisingly high—so much so, that it is possible to sacrifice a good deal of it in the interests of selectivity, and consequent setting accuracy. Apart from the transistors and two 1.5 volt cells, there is practically nothing in the circuit, physically. Circuit-wise, however, it provides an excellent example of transistor application, and how the different types of connection may be used to advantage. The easiest stage to understand is the output one, feeding the meter. This is used in a grounded emitter circuit, which as we have pointed out has close affinities with the conventional grounded-cathode triode circuit. The H.T. supply to the collector is a single dry cell—the one with its positive terminal earthed. The other is used merely as a zero-setting device for the meter, in conjunction with the 10k. variable resistor in series with 2.2k. fixed. The base circuit is completed not through a resistor, as it would be in most circuits, but through the emitter circuit of the previous transistor. Now, in a junction transistor, the emitter current is always slightly greater than the collector current, so that in the grounded base circuit, the current amplification is always slightly less than unity. In the grounded emitter circuit, however, the gain can be quite high, because the current flowing in the base circuit with this arrangement is the difference between the emitter and collector currents. Because the emitter current always exceeds the collector current, the direction of current flow in the base must be away from the base terminal. This is clearly in the right direction for current flow in the emitter circuit of the first transistor, so that we can see at a glance that however peculiar the arrangement may seem at first sight, the direction of current flow in the second stage is correct as far as producing the right kind of current flow in the first one is concerned.

Looking now at the first transistor, we see that it is connected in the grounded collector manner. But, you might say, the collector is not grounded, but connected to the battery at a potential that is negative with respect to ground. This is true, but the important point is **not** the D.C. potential of the collector, but that its potential, when signals are applied to the circuit, is unable to change. In this respect, it resembles a cathode follower, whose plate is at H.T. potential, but is fixed there because of the H.T. bypass condenser, and cannot change whatever signal voltage is applied to the grid. This is why the cathode follower is sometimes called the grounded plate circuit. In this case, the output is taken from the emitter circuit, by the simple dodge of placing it in series with the input electrode (the base) of the second transistor, which is in a grounded emitter arrangement. Now the 24k. resistor in the base circuit of the first transistor acts as a kind of bias resistor, holding this transistor close to cut off. Since its emitter circuit is in series with the emitter circuit of the second transistor, the latter, too, is held close to cut off. This means that the collector currents of both transistors will be very small, and so there will be very little current through the meter in the second collector circuit. Now through the blocking condenser, R.F. voltage from the tuned circuit is applied to the base of the first transistor. Positive half cycles of R.F. will make the base positive with respect to the emitter, and as this is equivalent to making the emitter negative with respect to the base, no current will flow in the emitter circuit of the first transistor, and there will be no output current. On the negative half-cycles, however, the situation is reversed, and the emitter conducts. Thus, the base and emitter of the first transistor act as a diode rectifier. Obviously there can be no voltage gain, but this transistor is acting as an amplifier, because the output impedance (i.e. the impedance of the emitter circuit) is much lower than that of the base input circuit. This is again similar to the cathode follower, and there is thus a large power gain. This is important, because otherwise it would not be possible to drive the input circuit of the second stage from the same value of R.F. input voltage. The base input impedance of the first stage is actually about 40,000 ohms, so that this, in parallel with the 24k. bias resistor, gives the circuit an input impedance of about 20k. This is quite high enough to enable the tuned circuit to excite it without spoiling the Q and selectivity, provided the tapping point is chosen so as to be well towards the earthy end of the coil.

The second stage is a D.C. amplifier, with a current gain of some 20 to 30 times, and this accounts for the somewhat staggering sensitivity of the whole device. So great is this, that in spite of tapping the tuned circuit at only a tenth of the turns from the earthy end, it is able to give readable indications several feet from such a minute power generator as the crystal oscillator we have already described. Perhaps the most important result of this great sensitivity is that the Q and therefore the selectivity of the tuned circuit is very much greater than that of any other absorption meter we have ever met. This in turn means that provided the dial used on the tuning condenser is an accurate one with no backlash, the measuring accuracy of this wavemeter will be correspondingly higher than that of any other of the same basic kind. It is indeed a far cry from the wavemeters of World War I, which had to absorb enough power to light a sizeable lamp before they could be read at all! The circuit is a really excellent example of how transistors can not only improve the convenience and portability of a well-known type of instrument, but at the same time, modify their characteristics for the better, and improve the design of the whole thing.

The supply voltage for the transistors is only $1\frac{1}{2}$ volts in the present case, the other cell being used only for backing-off purposes. It was found that the condition for greatest sensitivity was one in which the output transistor was not cut off, but passing an appreciable collector current. Thus, this current is backed off by passing an equal current through the meter in the opposite direction. In an instrument of this sort, in which the meter is used only as an indicator of resonance, very precise zero-setting, and very high zero stability are not required, so that we

can make full use of the properties of the transistors without having to worry about their disadvantages at all.

In the next part of this series, we will describe a personal portable broadcast receiver using two transistors, a loop aerial, and working from a battery supply of 9 volts at 1 milliampere.

(To be continued).

BOOK REVIEWS

"Mechanical Vibration," by G. W. Santen, and **"Television Receiver Design—1, I. F. Stages,"** by A. G. W. Uitjens. Both published by the Philips Technical Library.

These two books illustrate the diverse fields into which the subject of electronics takes one. The study of television is ipso facto a study of valve circuits of one kind or another, because modern television had to await the electronic valve before it could become a reality. Mechanical vibration, on the other hand, has always been with us, and has always been a source of difficulty to successive generations of mechanical engineers. Its effective study and understanding has, however, been vastly facilitated by the use of electronic methods of measurement, and of observation, to the extent that the study of vibration phenomena constitutes an important subdivision of what has become known as industrial electronics.

The first of these two books covers a very wide field. The first nine chapters are completely general in nature, and discuss the theory of vibrations of different kinds, the properties of springs, beams, and plates, the theory of isolation from vibration, and the propagation of virbation. Logically, one should be able to expect a treatment of the generation of sound vibrations, and in this the reader is not disappointed. Indeed, the treatment of sound is quite useful for anyone interested in musical instruments, sound treatment of buildings, and other aspects of acoustics, although the book makes no claim to being a text on this subject.

The succeeding chapters deal mainly with specific problems, although the treatment of these is carried out in as general a manner as possible. There are chapters about the principles of vibration measurement and on instruments for these purposes. Here, as might be expected, Philips apparatus is freely described, but the material can hardly be said to suffer on that account. The book forms a very useful introduction to the problems of Vibration, and at the same time should act as a useful reference text for those who may have to deal with specific problems from time to time, and yet are not fully occupied with the subject.

The volume on television I.F. stages, while containing a good deal of mathematics, is in no sense a theoretical treatise. While theoretical treatments of many aspects of wide-band amplification are given, these are all directed towards disclosing the practical requirements. This is in marked contra-distinction to many text-books, which, to give an example, give full treatments of the design of the wide-band amplifiers, neglecting stray capacities, and then fail to show how the design process must be modified by taking actual stray capacities into account if the labour is to be worthwhile. Unfortunately, the mathematical parts of the book are a little difficult to read, on account of the non-standard symbols that are used. A somewhat glaring example of this is the use of g_c to mean shunt conductance, when we are all used to its meaning conversion conductance. We must admit, however, that the author apologises for this one in a foot-note.

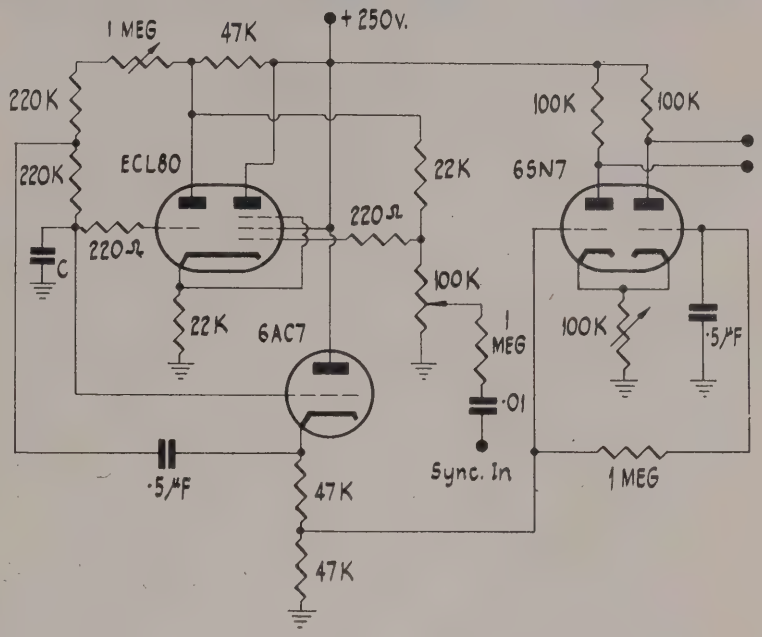
When it is stated that the book is one of some 180 pages, it will be realized that the treatment of this relatively small subject is quite a full one. It includes, for example, a treatment of the transient response of wide-band amplifiers whose pass-bands are organized to suit double or vestigial side-band operation. There are also chapters devoted to the noise per formance of wide-band amplifiers, and the effects of feedback. Altogether, a volume that all would-be television experts in this TV-less country should study and then keep for reference.

"A Text-book of Radar," by the Staff of the Radio Physics Laboratory, C.S.I.R.O. Australia. Second Edition, published by the Cambridge University Press.

Workers in radar outside Australia probably do not realize what an important contribution was made to the war effort by the Radiophysics Laboratory of the Commonwealth Scientific and Industrial Research Organization. The laboratory was set up in 1939, and during the war made a name for itself by developing radar sets which were specially designed to suit conditions in the Pacific theatre. Its staff of physicists, having been engaged in radar development since almost its earliest days, was therefore admirably fitted by training and experience, to undertake the task, once military security was relaxed, of setting out the technical bases of the subject for all engineers to read. In examining a text-book on this subject, the reviewer can hardly help making comparisons with the monumental series of texts produced by the staff of the Massachusets Institute of Technology, but in this case, the book loses little by the comparison. When it is realized that the whole subject has been compressed into a space of some 600 pages, without leaving out any fundamental topic, and at the same time including about one hundred pages on post-war development of radar applications and techniques, it says a great deal for the authors that they have succeeded in producing a readable book, whose treatment is consistent from one chapter to another. The authors' aim has clearly been to give the engineer or student an understanding of the whole subject in broad outline, so that if he wishes, he can then attack the more highly specialized volumes which deal with the detailed problems of design and performance, of the many component parts of the radar system. Accordingly, mathematics is sparingly used, and the book is consequently one which should appeal not only to engineers, but to students and Technicians. The third chapter, for example, gives what the reviewer considers to be the best non-mathematical picture he has yet seen of the functioning of the magnetron,

Circuits for the Experimenter

ANOTHER OSCILLOSCOPE TIME-BASE CIRCUIT



Many and various are the circuits that have been devised for use in oscilloscopes, and quite a number of them have appeared in the pages of this journal. As a subject, time-bases are a bit like audio amplifiers —there seems to be no end to them— but each has its own peculiarities and advantages, as well as its disadvantages. This one has quite an imposing list of advantages, which may be summarized in tabular form, thus:—

(1) Linearity

Provided the direct amplifier circuit illustrated is employed, linearity is excellent, down to frequencies of the order of 10 c/sec., and up to the highest usable frequencies. This is due partly to the cathode-follower type of linearizing circuit and partly to the use of direct coupling between the cathode-follower linearizing tube and the phase-splitting amplifier circuit. The latter feature eliminates phase shift at very low frequencies, and results in a substantial improvement in linearity at these frequencies even if the amplifier is not direct-coupled to the C.R.T. deflection plates, and in spite of the coupling condenser that must be used in the long-tailed-pair circuit.

(2) Constant Output Voltage

This is a very valuable feature, as in an oscilloscope it enables an X-gain control to be dispensed with if desired. The tap on the cathode-follower load resistor ensures that the amplifier stage is not overloaded, which is again made easy by the feature of constant output amplitude.

(3) Simplicity for Multi-range Switching

For variable-frequency work, only one condenser needs to be switched for range changing. This makes it easy to provide many frequency ranges, thereby making adjustment very easy. The 1 Meg. variable resistor is the fine frequency control.

From this small list, it can be seen that the circuit has much to recommend it. It really uses only two valves in the time-base circuit proper, and the amplifier stage has been included to give readers some idea of how the good linearity of the time-base itself may be preserved. It is our observation that many more time-bases have their linearity spoiled through the use after them of a poorly designed amplifier circuit, and for oscilloscope work at relatively low time base frequencies, the direct-coupled amplifier is undoubtedly the answer to this vexing problem.

HOW IT WORKS

The basic circuit is that of a multivibrator which has both couplings between valves D.C. ones, while the repetitive action takes place because the circuit charges, and then discharges the time-base condenser. It was originally described, in somewhat different form, by C. H. Banthorpe, in the April 1954 issue of "Electronic Engineering." The action of the circuit is as follows:—

On first switching on, the condenser C will be uncharged, so that the control grid of the triode section of the ECL80 will be at earth potential. The control grid of the pentode section will be at a relatively high positive potential, being directly connected to a potential divider across the H.T. line. Because of the high-value cathode resistor, the cathode of the pentode section will rise in potential, cathode-follower fashion, until it is a few volts more positive than its control grid. At the same time, therefore, the triode section will be firmly cut off. However, as time goes on, condenser C charges, and it finally reaches a point at which the triode begins to pass a little current. This causes a drop in potential at the triode plate, and therefore at the pentode grid, so that the pentode begins to pass a little less current. This in turn allows the common cathode to drop in potential, because the cathode current of the pentode section is greater than that of the triode section. The action described, namely of current increasing in the triode and decreasing in the pentode, is regenerative, so that in a very short time the triode is conducting heavily, and the pentode is cut off. Indeed, the triode is driven into grid current, thus providing a low-resistance shunt across the condenser, which rapidly discharges, giving the fly-back of the output saw-tooth. When C is sufficiently discharged, the current in the triode starts to decrease, and this in turn causes the cur-

rent in the pentode to increase. This action also is regenerative, so that the original state of affairs is rapidly restored. Then, C charges slowly again and the cycle is repeated indefinitely. The saw-tooth output of the circuit is taken from the "hot" side of the condenser C. Synchronization can be effected by feeding the synchronizing voltage into the grid of the pentode section.

Now, this circuit does not produce a highly linear saw-tooth on its own, for it uses the old device of picking out the first portion of the charging curve of a condenser. However, by adding the so-called bootstrap linearizing circuit, which consists of a cathode-follower connected so as to give positive feedback into the charging circuit, the linearity can be made so good that any departure can not be detected by the eye at middle and high frequencies, and is still remarkably good at very low frequencies. At 25 c/sec. and above, the linearity is as good as is often encountered in commercial oscilloscopes only above about 250 c/sec. Unfortunately, though, the output voltage is insufficient to give a respectably long trace on any cathode ray tube. Thus an amplifier is essential, and it was here that we ran into difficulty. The main cause of non-linearity at low frequencies has already been mentioned, namely phase shift, due to too many RC couplings. Thus, the best way of eliminating the distortion of the saw-tooth is to attack the problem at its source, and do away with as many of the RC couplings as possible.

In using the long-tailed pair circuit for the amplifier, we obtained enough output voltage to swing the X plates of a VCR97, and also obtained the benefit of balanced deflection for the X axis. This is well worth having, as it does away entirely with the annoying deflection de-focussing effect that is so noticeable on displays which have unbalanced X deflection. The effect is much worse where both X and Y deflections are unbalanced, and using balanced X deflection makes it possible to have quite a good picture even if unbalanced is used for the Y axis. This means that a simple and inexpensive amplifier can be used for the Y plates if desired. There is a 100k. variable resistor in the cathode of the 6SN7. Its purpose is to set the operating conditions for this valve, and it can best be a pre-set, only to be used when valves are changed. It has the further advantage that if a different type of tube is plugged into the socket as a temporary replacement, the correct bias can be found for it by adjusting this control. If this should be done, it may also be necessary to alter the amount of signal fed from the cathode follower. The simplest way of doing this is to shunt resistors across the lower 47k. resistor until overloading no longer occurs, as shown by the ends of the pattern cleaning up again. Provided that too much signal is not fed to the 6SN7 (and with the values shown it will not be), the best adjustment of the 100k. variable was found to be the one that gave maximum gain. Some users of the circuit might like to make the cathode load of the 6AC7 another 100k. variable resistor, in which case he would have complete control not only of input to the amplifier, but also of its bias. The latter control would have to be set to its best position after any change was made in the setting of the input control, because the latter also alters the D.C. bias on the amplifier. However, the adjustment would not be at all tricky, and would enable the absolute maximum undistorted output voltage to be obtained from the circuit.

FREQUENCY RANGE

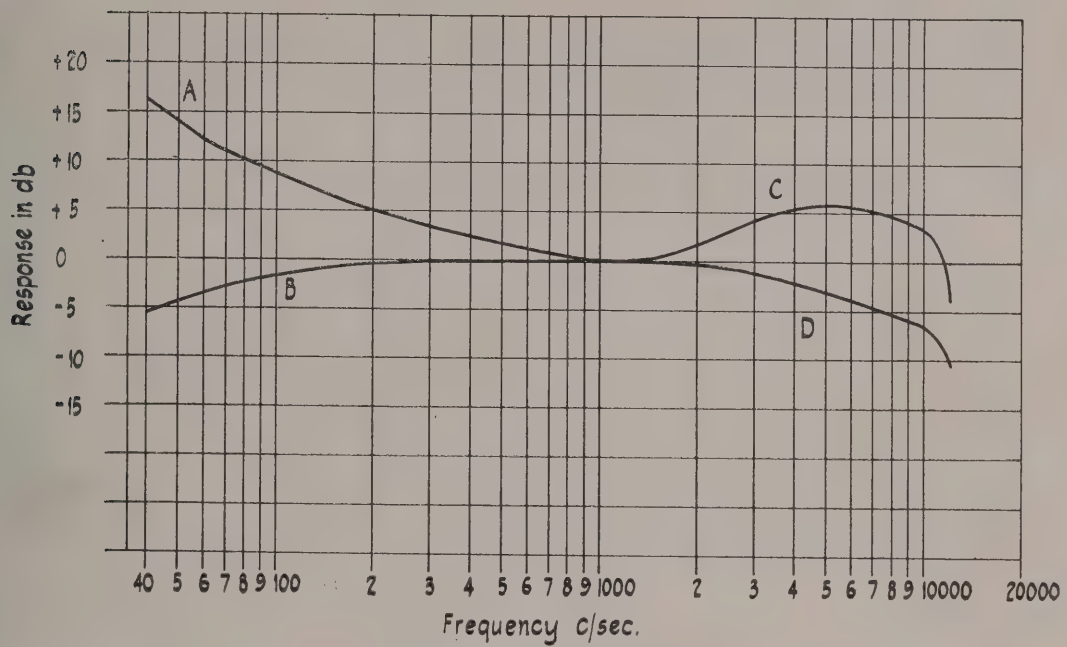
Using standard 20% tolerance components, the following frequency ranges were obtained when C was varied.

Value of C	Freq. Range
0.25 μf.	7 – 20 c/sec.
0.1 μf.	18.5– 55 c/sec.
0.03 μf.	55 – 155 c/sec.
0.01 μf.	150 – 450 c/sec.
0.003 μf.	450 –1650 c/sec.
0.001 μf.	1650 –5000 c/sec.
300 μμf.	5 – 15 kc/sec.
100 μμf.	14 – 41 kc/sec.
30 μμf.	42 – 110 kc/sec.

This range is a good deal wider than will be needed for many purposes. For most purposes, the bottom range, and the two top ones could well be omitted, which would leave only a six-position switch. However, the switching is so simple that there is little point in leaving out the additional ranges.

Should anyone wish to use valves other than those specified, we would recommend that he stick to the ECL80, if he wants to avoid experimenting with circuit values. As for the other valves, a wide variety of other tubes could be used with no change in values, other than to provide for continuous variation of the amplifier input voltage, in the manner suggested above. For the 6AC7, almost any high-Gm pentode, connected as a triode will fill the bill. For instance, this tube could be an EF50, EF80, or 6AG7. It could even be a triode-connected output pentode of almost any type number. The double triode, too, could be almost anything except the very high-mu variety, such as the ECC35 and 6SL7. Suitable types would be ECC32, ECC34, ECC40, 6J6, 12AT7, and so on almost ad lib.

A NEW PRE-AMPLIFIER AND TONE-CONTROL CIRCUIT FOR RECORD REPRODUCERS—Part 2



Showing response curves of the tone-control circuits with the controls in the extreme positions

ADDING TO AN EXISTING AMPLIFIER

In the interests of simplicity, the circuit given in this article does not include a cathode follower stage, nor have we shown a power supply for it. With its low over-all gain of four times, and its small H.T. drain of about 5 m.a., there is little reason why it should not be powered successfully from the power pack supplying the main amplifier. With high-gain pre-amplifiers, this is sometimes unwise, and results in motor-boating, even when fairly extreme precautions are taken by way of decoupling. With low over-all gain, however, the risk is considerably lessened, and if no trouble of this sort occurs, there is no reason why a separate power supply should be used.

Similarly, many builders will no doubt wish to put the pre-amplifier circuit on the same chassis as the main amplifier, in which case a cathode follower stage will be unnecessary. On the other hand, if it is preferred to build the pre-amplifier on a separate chassis, it is a simple matter to add a cathode follower, using any of the fairly numerous circuits for such things that we have published in these pages. As the overall gain is not very high, and the output is likely to be half a volt or more, hum trouble is very unlikely, unless it is caused by a "ground loop". This sort of hum is often encountered when the amplifier and pre-amplifier are on separate chassis, and is due to the chassis not being at the same potential. If the pre-amplifier has its own power supply, it is a simple matter to avoid a ground loop type of hum developing by ensuring that the only earth between the chassis is the one incorporated in the shielded lead carrying the signal to the main amplifier chassis. It is best to use a shielded cable with two insulated conductors, one of which is used as the earth lead between the chassis. This should be taken to the earth point of the first valve in the main amplifier, and to the earth point of the cathode follower circuit in the pre-amplifier. If hum is found to be excessive, make sure that no other earth paths exist between the two chassis. An unsuspected one can be via the power plugs, if both chassis have their own supplies, connected to the mains by separate plugs. The usual cure in such a situation is to disconnect the earth wire on one of the plugs—preferably on the one that comes from the pre-amplifier. If this cures the trouble, the best solution is to do away with one plug altogether, by taking the A.C. leads from one chassis to the other with a plug and socket at one end. This is quite permissible, because the chassis are earthed by the signal lead, and the earth terminal on the remaining A.C. plug and socket.

RESPONSE CURVES

The diagram printed here shows the maximum extent of the frequency response variation obtainable. It should be remembered that the four curves shown are the extreme positions of the controls, and since the bass and treble controls act quite independently of each other, any combination can be obtained

(Concluded on page 50).

RECORD TALK

By JOHN GRAY

The march of the 45s is gathering momentum with the release, on Festival, of several extended play discs of that speed. They give up to fifteen minutes of music and the small initial release is doubtless the first of many. A potted version of "The Vagabond King", with Alfred Drake and Mimi Benzell, is on two discs numbered XP45-451-2, while Leslie Bridgewater's Westminster Light Orchestra plays four Hungarian Dances by Brahms on XP45-453 and four attractive pieces by Tchaikovsky on 455. Among normal 10-in. LPs, Festival are offering Al Jolson in some of the most enduring numbers on CFR10-499. Another veteran of the earlier days of electrical recording turns up on CFR10-502. Jesse Crawford, whose popular organ records sold by the thousand in the old days, is still as active as ever and many of his old favourites are revived on this disc. Then there are two real jam sessions, recorded under the title of "Jazz from Studio One" (CFR12-492) and, for opera fans whose funds and inclinations do not run to complete recordings, there are cleverly compressed versions of "La Boheme" and "Madame Butterfly" coupled on CFR10-339. The singers are from the opera in Vienna, and from the same city our old friends the Deutschmeister Band may be heard in a further selection of stirring Austrian music on Westminster WL 3007.

Philips are drawing attention to their records by Winifred Atwell, the irrepressible pianist now in the midst of an Australian tour. Another of her "party" records B26154, appropriately called "Let's have another party", will be receiving a warm welcome, while on P28516 she is heard in the fiery "Vendetta" and a revival of that favourite of the twenties, the Charleston. Another pianist to capture the public imagination is Liberace. Whatever one may think of his mannerisms and publicity stunts, they do not affect his records, two of the latest of which feature "Oh promise me" and "I love you truly" on PB 319, and "The Doll Dance" backed by "Cucaracha Boogie" on B21441. Those who prefer the Continental style may be directed to PB297, whereon Henri Leca and his Orchestra are heard in "The Bandit", plus a selection of further numbers from the film in which this tune appears.

Radio Corporation have not been slow in reacting to the interest aroused, in the North and elsewhere, by the personal appearances of Nat "King" Cole. His caressing, confidential style of vocalism shows to advantage on all his discs and one of the most appealing contains "Smile", the old Charlie Chaplin theme tune which is currently enjoying a revival (CP 350). Another, also destined for big sales, couples "Tenderly" with "A little street where old friends meet" (CP 349). Among the long-playing discs is one recorded from the sound track of the first Australian cinemascope film, "Long John Silver". This is splendidly evocative music with a nautical flavour and although such music is not always effective when divorced from the action it is meant to underline, the disc should give pleasure and arouse lively curiosity as to the film itself, in which Robert Newton is featured. The orchestra is the Sydney Symphony under the composer, David Buttolph (Pacific LLP01). The disc contains only music, by the way. The delightful children's feature, "Rusty in Orchestraville", in which the orchestral instruments are introduced in a most entertaining manner, is now available on three Capitol discs packaged in an album (CP336-8). Included in Capitol's classical issues is a splendid coupling of Mozart's Haffner and Jupiter symphonies by the Pittsburgh Symphony Orchestra under Steinburg, on CLC033.

The latest Radiola-Telefunken list is almost entirely devoted to serious music and features at least two items of exceptional interest. Last month we noted the resurrection of some brilliant Beethoven performances by Mengelberg. This month appears a pre-war recording of the Beethoven violin concerto, played by the late Georg Kulenkampff with the Berlin Philharmonic under Schmidt-Isserstedt (LE 6507). The consensus of opinion overseas is that this is still the best version as a performance and by no means outmoded as a recording. Schmidt-Isserstedt, the conductor of this historic performance, is still a major figure in the musical world and has recently appeared as a guest conductor in Sydney. On that occasion Radiola seized the opportunity of recording a performance of the Sydney Symphony under his baton—and it now appears on disc LB 5005: Haydn's Oxford Symphony in G major.

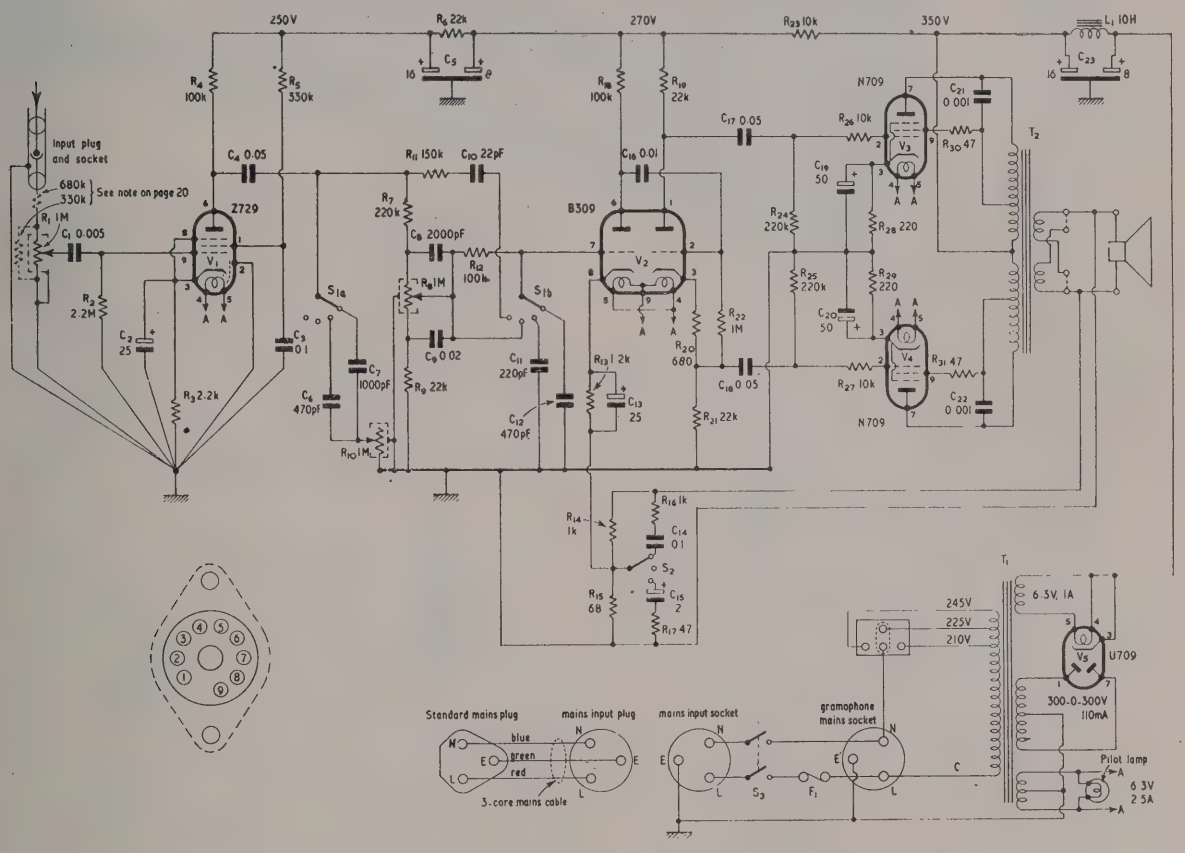
H.M.V. are stepping up their production of popular discs and are now offering dozens of old and new favourites. You can be up to the minute with the Four Aces in "Mister Sandman" (Col DNZ 5031) or Vera Lynn's "My son, my son" (Decca Y 6650) or you can revive old memories with two discs of "Student Prince" numbers, as sung by Mario Lanza for the recent film (HMV EC 223-4). Mantovani revives that old favourite "Ramona" on Y 6606 and Ronnie Ronalde takes us back to "Mockin' Bird Hill" on DB 2852. Another crop of 45 r.p.m. extended play records is worthy of attention, as it contains some exceptional bargains in a very handy form. For opera fans are four arias, sung by that prince of tenors Jussi Bjorling on 7ER 5025, and four numbers from "La Boheme" on 7ER 5028 enlist the talents of Licia Albanese, Patrice Munsel, Giuseppe di Stefano and Leonard Warren. The Boston Promenade Orchestra are well to the fore in the plum label series. Several of the titles have been familiar for many years, but in all cases they are new recordings by this indefatigable orchestra under Arthur Fiedler. There are four Sousa marches on 7EG 8808, and the coupling of "Marche Slav" with "In a Persian Market" on 7EP 7010 is sure to be a popular one. In the Columbia series, several excerpts from their recent "Messiah" set are served up in "pocket editions".

At the head of HMV's newest release of LPs stands a Wagner record which is a monument to two great artists, one alas deceased, the other retired. The closing scene from "Twilight of the Gods" is sung by Kirsten Flagstad with the Philharmonia Orchestra under the late Wilhelm Furtwangler in a performance which will surely pass into history. It is coupled on ALP 1016 with Siegfried's Rhine Journey and the Funeral March from the same opera, in which Furtwangler conducts the Vienna Philharmonic. Not only does this disc offer some of the greatest passages in all Wagner, but the performances set a standard. HMV have also revived another classic performance—Beethoven's "Archduke" trio as played by Rubinstein, Heifetz and the late Emmanuel Feuermann, on ALP 1184, while the remainder of their list contains largely a galaxy of pianists. There is a choice between two performances of Schumann's Fantasia in C major, for instance: Brailowsky on ALP 1168 coupled with the "Carnaval," and Moiseivitch on CLP 1017 (at a cheaper price) coupled with the Brahms Variations on a theme by Handel. Dame Myra Hess plays the last two Beethoven sonatas on ALP 1169, the first solo recording we have had from her for some time. On ALP 1170 Rubinstein completes his issue of the Chopin Nocturnes, and there is a recital by Horowitz on ALP 1111 which includes the third and fourth ballades and the first scherzo. And to complete this pianistic galaxy—one might even say orgy—Brunswick AXTL 1043-4 appears, boldly titled "Chopin complete works for piano, Volume 1." The famous Claudio Arrau is the artist here, and on this first pair of discs he disposes of the entire set of ballades, scherzi and impromptus, plus the barcarolle.

To scale the musical heights there is a release of Beethoven's Missa Solemnis conducted by Toscanini (ALP 1182-3). Those who prefer to wander in the foothills may be directed to a pair of plum labels (CLP 1019-20) on which all sixteen of Dvorak's Slavonic Dances are played by the Philharmonia Orchestra under Nikolai Malko. In pre-war days many of us used to collect these delightful pieces as they came out on an assortment of 10 and 12-inch records as played by the Czech Philharmonic Orchestra. It was obviously time for new versions, and if you want one or two dances you will doubtless want them all, so this LP issue is the answer. On the fourth side of the set is a further bouquet in the shape of Grieg's "Lyric Suite". Another plum label issue is DLP 1006 containing Gina Bachauer's fine performance of the Mozart "Coronation Concerto" in which this pianist plays with the New London Orchestra under Alec Sherman. Not one of the great Mozart concertos, perhaps, but a most enjoyable work and so far available here only in this version, which should cause no prospective buyer to hesitate. That famous old standby of the pianist's repertoire, the Tchaikovsky Concerto No. 1, turns up again in what one is tempted to call a "once and for all" performance on Columbia 33CX 1156. The pianist is Geza Anda, and his name is now one of the foremost in a very crowded field. He has splendid support from the Philharmonia under Aleco Galliera and gives us an encore to round off the disc; a Delibes waltz, not "Naila" this time but "Coppelia". The main interest on the instrumental side of this Columbia release, is contained in two discs of 18th century music played by two of those small chamber orchestras which have recently become so popular on records. One is a group of 12 Italian players who call themselves simply "I Musici"—"The Musicians". They make their debut on 33CX 1170 with four short pieces by Antonio Vivaldi, who wrote literally hundreds of concertos and whose posthumous fame has been enormously enhanced since the invention of LP records. The other combination is the Alessandro Scarlatti Orchestra of Naples who appear on 33CX 1171. They play a symphony, two concertos and an overture, and the composers represented were, appropriately, all connected with Naples at some time during their careers—Scarlatti himself, Cimarosa and Paisiello.

THE OSRAM 912 AMPLIFIER

Of interest to audio fans will be the circuit, which we reproduce below, of the Osram 912 Amplifier. This is a high-quality amplifier that has been designed specially for home construction by F. H. Britain, of the G.E.C. It is intended to be specially suitable for driving the new G.E.C. metal-coned loudspeaker. Booklets giving detailed descriptions of the construction of this amplifier are available locally from the British General Electric Co. at a moderate price.



Circuit diagram. The valve base diagram represents the valve bases or sockets as seen from under the chassis. The various mains plugs and sockets are drawn as though looking at their terminals.

Paul Kletzki conducts the Philharmonia Orchestra with soloists and chorus in a virtually complete presentation of Mendelssohn's "Midsummer Night's Dream" music on 33CX 1174 and is also in charge of three standard works, Tchaikovsky's Serenade for Strings, the overture to "The Bartered Bride", and Ravel's "Bolero", on 33CX 1164. This reminds us of a similar collection of standard favourites in HMV's plum series. Rudolf Schwarz conducts the Philharmonia in Schubert's "Unfinished Symphony", Weber's overture to "Euryanthe" and Liszt's "Les Preludes". Such discs are highly convenient, if you happen to want all of these particular works!

There is only one complete opera this month, but it is a great one and is not available in any other recording. Some of us consider Bellini's "Norma" to be the best Italian grand opera written before the advent of Verdi. It has a highly dramatic story told in music that is by turns powerful and tender, and contains a stream of beautiful melodies. The principal part is so difficult, however (it calls for a coloratura, a lyric and a dramatic soprano all rolled into one) that no more than a dozen singers have been identified with it throughout the past thirty years. Of these, the Greek-American soprano Maria Meneghini Callas is now virtually without a rival. A recording of her most famous role was inevitable, and now is here, on 33CX 1179-81, surrounded by the full panoply of La Scala with a veteran conductor, Tullio Serafin, and a largely distinguished cast of supporting principals. It has also been received with a chorus of "ifs" and "buts" by the more severe of the English critics, who fly against all practical considerations in demanding perfection. Maybe the singing of Callas is not flawless. Ebe Stignani has been singing the mezzo role since the 1920s and has outlasted quite a number of Normas, thus her performance in 1954 has not the bloom of former years. The tenor, Mario Fileppeschi, is a powerful and unsubtle singer (which exactly fits the character he has to portray) and the bass, Rossi Lemeni, is anything but a Pinza. All this is cheerfully granted. But the fact remains that by today's standards this is a wonderful "Norma"—the opera has been re-

(Continued on page 51).

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ELECTRICAL AND TRADE SECTION

REFRIGERATION: Part I

(Published through the courtesy of the publishers of "The Practical Electrician's Pocket Book, 1955)

Refrigeration is the process of removing heat: it is a common but mistaken idea that a refrigerator produces "cold." Cold is never produced, but by removing heat we reduce the temperature of the interior of the refrigerator. The operation of a refrigerator is based on three fundamental physical laws:

(1) Heat always flows from a hot body to a cold body, tending to bring the two bodies to the same temperature. This heat is transferred by (a) conduction, (b) convection, and (c) radiation. All materials do not have the same conduction, and therefore poor conductors, such as cork, fibreglass, kapok, etc., are used to insulate the refrigerator walls.

(2) The change of state of a liquid to gas requires heat, and vice versa; thus, to liquefy gas requires the removal of heat, such heat being called "latent heat."

(3) The boiling-point, or point of liquefaction, varies with the pressure, the higher the pressure the higher the boiling-point.

Many liquids could be used for refrigeration, but when the design problems of the compressor are considered, together with the chemical properties of the particular liquid, the ideal refrigerant should have the following main characteristics: low boiling-point combined with reasonably low condensing pressures, non-corrosive to metals, non-toxic, non-inflammable, and reasonable in cost. The most commonly used refrigerants are given in the table, with their temperatures and corresponding pressures for evaporation. The first three of these are mainly used for domestic and small commercial plants, while the use of ammonia and carbon-dioxide is mainly confined to larger installations.

REFRIGERATING SYSTEMS

Refrigeration could be accomplished by allowing a liquid having a low boiling-point, such as SO_2, to evaporate in a container within the refrigerator, the vaporized refrigerant being carried away to the outside air. Evaporation of the liquid would absorb the heat from the refrigerator, but, of course, the refrigerant would be wasted. In order to eliminate such a loss of refrigerant and to produce continuous refrigeration, the refrigerating system is entirely closed and a compressor is used to draw away the refrigerant vapour and convert it back into liquid form so that it can be re-evaporated and used for an indefinite period.

Figure 1 outlines the parts of a practical system which comprises the following eight component parts.

(1) A cabinet or room, insulated to prevent too rapid ingress of atmospheric or other heat; (2) an evaporator or freezer unit, inside the cold compartment, where the liquid can evaporate and remove heat from the air and articles in the compartment; (3) a liquid or refrigerant that is a good absorber of heat which evaporates and condenses at suitable temperatures and pressures; (4) a compressor, to create, on one side, the low pressure required for evaporation, and, on the other, a high pressure to bring about condensation; (5) a condenser or radiator which will give off to a cooling medium, such as oil or water, the heat extracted from the cold compartment plus heat added due to the mechanical work of the compressor; (6) a pressure reducing or expansion valve to regulate the flow of liquid into the evaporator or freezing unit, maintaining a high pressure on one side and a low pressure on the other; (7) an electric motor to drive the compressor direct

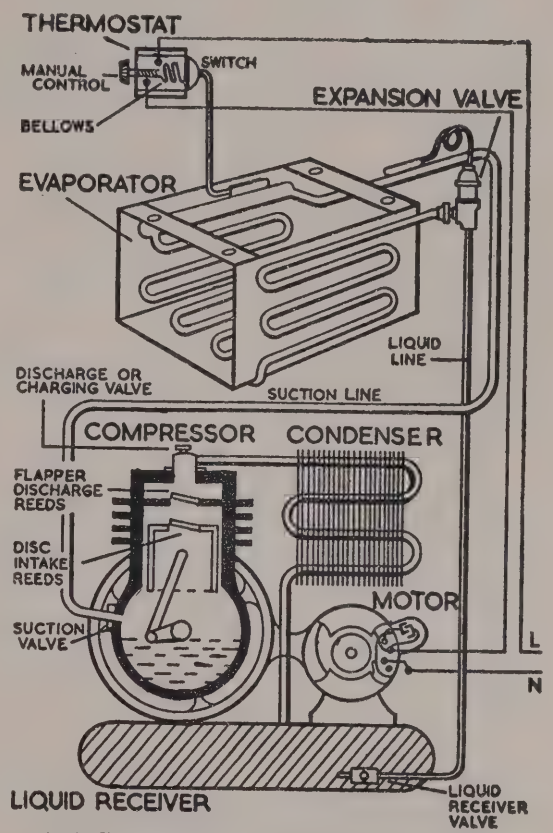


Fig. 1—Essential components of a compressor refrigeration system and how they are inter-connected.

or by means of belts; (8) an automatic device to start and stop the motor, so that heat is extracted at the rate necessary to maintain the desired temperature in the compartment (this may work on refrigerant pressure or temperature) and fitted with a manual control to enable the cabinet temperature to be altered at will. These elements of a refrigerating system are described in sequence on the following pages.

ABSORPTION SYSTEMS

Before dealing with compressor systems in detail, it should be noted that the refrigerating cycle can be driven by heat instead of a compressor; in the absorption type, the compressor is replaced by a boiler, heated by an electric element or gas flame. The refrigerant ammonia boils, the vapour under pressure passes to a condenser, where it gives up heat received both in the boiler and cold compartment. The ammonia condenses and flows to the evaporator, where it mixes with hydrogen and evaporates, taking in heat. The mixture of ammonia and hydrogen flows to an absorber, where it finds a weak solution of ammonia and water, which has circulated from the boiler. The solution takes up the ammonia and returns to the boiler, where the ammonia and hydrogen separate, the ammonia going to the condenser, where the cycle recommences.

This type of refrigerator is cheaper to manufacture than the compressor type, but more expensive to run. Due to the pressures involved, the plant is larger; in domestic refrigerators, the cold compartment is reduced in size in comparison with the compressor type.

COMPRESSOR REFRIGERATORS

We now return to the compressor type, and take each component part and see how it works and what it is like.

(1) Domestic Cabinet.—Cabinets are usually constructed of high-tensile pressed steel, welded to exclude moisture and give strength and rigidity. The cold compartment is usually made of pressed steel, vitreous enamelled, and rounded at the corners for easy cleaning. This is lagged with insulation, "fibreglass" being the most commonly used.

(2) Evaporator.—The evaporator or freezer is, in the case of a domestic refrigerator, usually a U-shape unit made of stainless steel, or sheet copper, with a coil of tinned copper tube in close contact.

Evaporators are classified as dry expansion or flooded type, depending on the manner in which they operate. A dry expansion evaporator is one in which the quantity of liquid refrigerant in the chilling unit is small, while in the flooded type the evaporator is practically filled with liquid refrigerant and incorporates a **header,** or reservoir, for liquid refrigerant. The design of chilling unit depends very largely on the application for which the refrigerator is to be used, and the modern tendency is to use the dry expansion system with the exception of the small domestic machine, which, as a rule, has a flooded evaporator. Each chilling unit or evaporator must be designed to suit the particular application and size of refrigerator required, and these range from small stainless steel or copper evaporators for domestic refrigerators up to coils fabricated from solid drawn-steel tubing.

(3) Refrigerant.—Arcton 6, which is British and equivalent to the American Freon 12, and Methyl Chloride (CH_3Cl) are widely used in small domestic and commercial refrigerators; they are replacing sulphur-dioxide (SO_2), which has an objectionable smell and forms sulphurous acid if water enters the system. Ammonia (NH_3) and carbon-dioxide (CO_2) are mainly used in large commercial plants. F12 and CH_3Cl are classed as low-pressure refrigerants, and CO_2 and NH_3 as high-pressure; the latter need heavier machine parts.

(4) Compressors.—The most commonly used compressors are of the reciprocating type, although a rotary has also been popular, but so far only in the small refrigerator systems.

The duty of the compressor is, first, to act as a suction pump by drawing off the low-pressure gas vapour; secondly, to compress the gas to a high-pressure high-temperature vapour to liquefy it. From the flapper discharge valve to the entrance to the expansion valve is high pressure and from the exit of the expansion valve through the evaporator, back to the suction side of the intake reed is low pressure. The different pressure sides of a system which is running correctly can be identified by touch, the high-pressure side being at a higher temperature than the low side.

The internal valves of refrigerating compressors are of two types, suction or intake, and delivery or discharge. On the upward stroke of the piston, the suction valve is closed, and the delivery valve open, allowing gas to be pumped into the condenser. On the downward stroke, the discharge or delivery valve closes, and the suction valve opens, thereby sucking in the low-pressure gas from the evaporator. Normally, service or stop valves are fitted to the discharge and suction sides of the compressor, so that it can be isolated for repair. These valves have two seats—one, the front seat, isolates the suction and discharge pipes, the other, the back seat, isolates the part supplied in the valve for fitting test gauges.

Hitherto, the compressor, with electric motor coupled by belt, together with condenser, fan, and liquid receiver, have been separate components mounted on a plate, sprung to minimize vibration. This construction involves the use of various pipe joints, these being made with a special flaring tool, and there is always the possibility of these admitting air, water, and dirt to the system.

An increasing number of manufacturers are now using the hermetically sealed unit. In this (which is either the rotary or reciprocation type), the electric motor and compressor are enclosed in a completely sealed and welded steel housing. The evaporator is coupled to the unit by the suction and liquid lines by the manufacturer and cannot be taken apart. Projecting shafts and shaft seals are eliminated, and this, with the complete absence of gasketted joints and flare connections, positively excludes air, dirt, and moisture. Direct drive eliminates belt slipping and wear, and the close grain of the rolled-steel housing offers greater resistance to seepage by some of the more penetrating refrigerants.

(5) Condensers.—The change from gas to liquid takes place in the condenser, which is designed to dispose of the heat released. In the case of the small domestic refrigerators using the sealed unit, this is of the cross-finned type, set at an angle, so that maximum air passes through it, and therefore it does not require a fan.

On the larger type of unit, a cross-finned condenser is fitted, assisted by a fan or a water-cooled con-

denser. The water-cooled condenser is a steel cylinder, with water tubes inside, and there is a temperature difference of 10 to 15 deg. F. on the water entering and leaving the condensed, and of approximately 18 deg. F. in the temperature of the air before and after entering the condenser. Water is by far the best cooling medium, especially on hot days, but water has to be paid for and air is free. Also, it has been proved not to be a practical proposition to use water-cooled condensers in small household cabinets.

(6) Refrigerant Control Valve is one of the most important parts of the refrigerating system; it is the dividing line between the high-pressure and the low-pressure side, and must regulate the amount of refrigerant entering the evaporator so that the total evaporator surface is effectively used for the removal of heat from the refrigerator. There are five general types of refrigerant control in common use today:

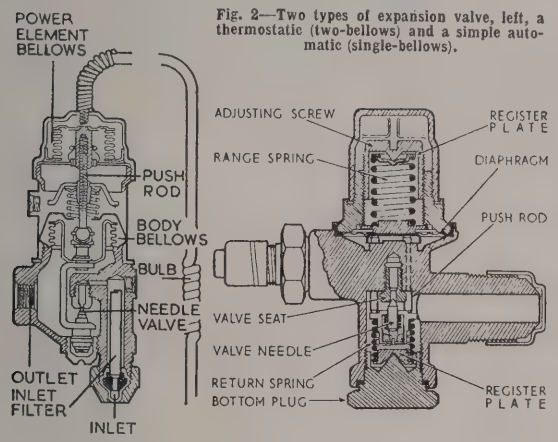


Fig. 2—Two types of expansion valve, left, a thermostatic (two-bellows) and a simple automatic (single-bellows).

(1) High-side float;
(2) Low-side float;
(3) Impedance tube;
(4) Automatic expansion valve;
(5) Thermostatic expansion valve.

The first three of these are used on flooded type evaporators, and the last two on dry-expansion evaporators.

HIGH AND LOW-SIDE FLOATS

In both these cases, a float, either of the bucket or ball type, is used to control the flow of liquid through a needle valve. In the first case, the float is immersed in the high-pressure liquid in the evaporator itself. The operation of both of these valves maintains a uniform amount of refrigerant liquid in the evaporator; as soon as the level falls, the needle valve opens, allowing a fresh supply of refrigerant to enter the evaporator.

AUTOMATIC EXPANSION VALVES

Automatic expansion valves are used on a dry-expansion system to control the liquid refrigerant flow into the evaporator; this valve is actuated by the pressure within the chilling unit. The pressure in the evaporator operates on a bellows inside the valve, so as to maintain a constant pressure in the evaporator. This type of valve is mainly used for small domestic applications, as it has certain disadvantages over the thermostatic expansion valve which is described next.

REFRIGERANTS—Temperatures and Pressures.

	Sulphur-Dioxide SO_2	Freon 12 or Arcton 6 $C.Cl_2F_2$	Methyl-Chloride $C.H_3Cl.$	Carbon-dioxide CO_2	Ammonia $N.H_3$
—40°F	23·5 ins.	11·0 ins.	16·0 ins.	131 lbs.	8·5 ins.
—20°F	18·0 „	0·5 lbs.	6·75 „	200 „	3·5 lbs.
0°F	9·0 „	9·0 „	3.75lbs.	291 „	15·5 „
10°F	2·5 „	14·75 „	8·75 „	345 „	24·0 „
20°F	2·5 lbs.	21·0 „	13·5 „	407 „	33·5 „
30°F	7·0 „	28·5 „	20·3 „	476 „	45·0 „
40°F	12·5 „	37·0 „	28·0 „	553 „	58·5 „
60°F	26·25 „	57·75 „	47·3 „	734 „	93·0 „
80°F	45·0 „	84·0 „	72·25 „	954 „	138·0 „
100°F	69·75 „	117·0 „	102·25 „	—	197·0 „
120°F	106·25 „	157·0 „	139·25 „	—	272·0 „

Room Temperature Degrees F.	Condensing Pressure		
	Freon.	Methyl Chloride	Sulphur Dioxide
100	175	152	109
90	153	134	90
80	135	117	75
70	122	103	61
65	113	95	54
60	106	87	45

THERMOSTATIC EXPANSION VALVES

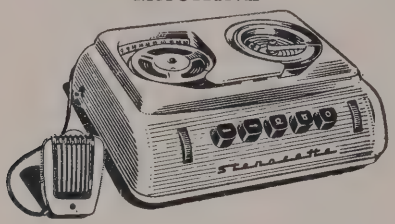
Thermostatic expansion valves are the most widely used form of refrigerant control today. This valve is not actuated by the internal pressure of the chilling unit alone, and therefore does not suffer from the disadvantage of the automatic expansion valve. It will admit the maximum quantity of liquid refrigerant so that the evaporator coil is efficiently used under the varying conditions usually found on any commercial application. Figure 2 gives a diagram of a typical thermostatic expansion valve. The operation is as follows: as soon as the compressor starts the pressure in the evaporator is reduced, and therefore the force exerted in the gland bellows is also reduced. The thermostatic bulb is clamped to the suction line as it leaves the coil, and this is comparatively warm at the start of the cycle. This bulb contains a small quantity of the same liquid as is used in a refrigerating system, therefore the pressure in the bellows, which is attached to the thermostatic bulb, is high. The pressure in the thermal bellows presses against the gland bellows through a push rod and overcomes this pressure to open the needle valve. This needle will then assume a position in operation where the force exerted by the thermostatic bellows, plus that exerted by some internal springs, equals the force exerted by the gland bellows. As the force exerted by the thermal bellows is dependent on the temperature of the suction line, the thermostatic expansion valve operates to maintain a uniform degree of temperature difference between the inlet and outlet sides of the evaporator coil, thus ensuring that the whole of the surface is efficiently used.

(Continued on page 51).

NEW PRODUCTS: LATEST RELEASES IN ELECTRICAL AND ELECTRONIC EQUIPMENT

This section of our paper is reserved for the introduction of new products and space preference is given to our regular advertisers. For further particulars contact Advertising Manager, R. & E., Box 8022, Wellington.

THE GRUNDIG "STENORETTE" DICTATING MACHINE



The latest release from the World-famous "Grundig" factory in London is the amazing little "Stenorette" office dictating machine.

Weighing only twelve pounds, and therefore being easily portable, the "Stenorette" gives wonderful Sound-reproduction on Magnetic-tape and is claimed to be the lowest priced dictating machine on the New Zealand Market. The "Stenorette" has a total dictating time of twenty-five minutes, and features easy-to-operate controls. A foot-operated remote-control giving instant stop/start facilities, and a backspacing control incorporated in the transcription unit, are further worthy developments of this very modern dictation machine.

This latest Grundig product also boasts an exclusive "finder-dial," which locates in seconds, any particular piece of dictation! Backed by the famous "Grundig" trademark the "Stenorette" office dictating machine should become a true favourite with radio and electrical dealers, as its convenience, portability and amazingly low price make it a sure-seller in its field!

Sole N.Z. Factory Representatives for the "Stenorette" are:

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* * *

ULTIMATE 6 VALVE BANDSPREAD MANTEL IN MAHOGANY CABINET

The Ultimate "Minnow" is a remarkably efficient 6 valve Bandspread Mantel designed to perform equally well on broadcast or short wave. It is housed in a solid Mahogany Cabinet and gives maximum performance and appearance. The powerful circuit, with its pretested dependable components, is sensitive, and selective on broadcast and short wave, the short wave having a range from 16 to 49 megacycles on three bands of separate tuning.

The Ultimate "Minnow" is the only set under £40 retail which has a three gang condenser on broadcast, giving that increased selectivity so important to the country listener in New Zealand.

Additional features include a heavy duty power transformer, 6/9 elliptical speaker, variable tone control, spin tuning, record player switch and sockets, plus extension speaker terminals. The large colourful

dial with its escutcheon surround is the polystyrene unit which recently gained a second place in the New Zealand Institute of Plastics competition for all manufacturers of plastic industrial components and domestic wares. The dial is moulded into one intergral part, allowing wide station separation, full wave band indication, easy tuning, and balanced cabinet design.

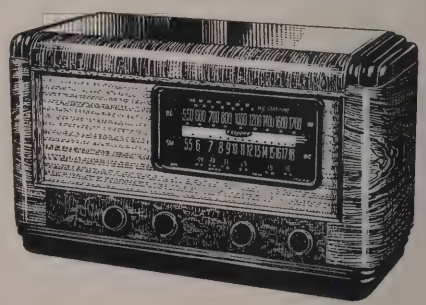
The Ultimate "Minnow" 6 valve Bandspread Mantel receiver is an outstanding example of contemporary cabinet design, with high receiver performance. It retails at £39 19s. 6d. The speaker is a 6/9 Rola.

Dimensions: 18¾ in. long. 14⅝ in. high. 9 in. deep.

Inquiries should be addressed to Radio (1936) Ltd., P.O. Box 1166, Auckland.

* * *

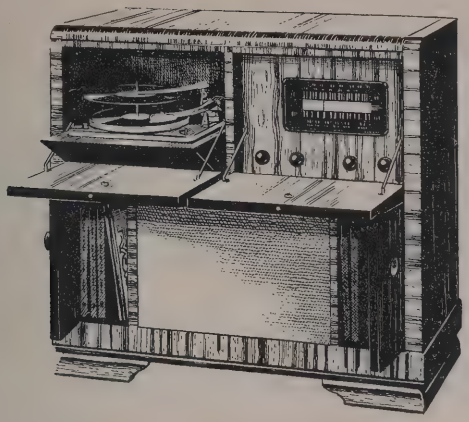
ADDITIONS TO THE CLIPPER RANGE MANTEL MODEL 725



From G. A. Wooller and Co. come two notable additions to the Clipper range, which already includes radios and radiograms from portables to consoles.

The two models recently introduced are a mantel model of pleasing design and generous proportions, and an elegant radiogram using the same chassis design with the addition of one of the completely reliable Garrard 3-speed automatic changers.

Both radio and radiogram are 7-valve, dual-wave models, incorporating an R.F. stage, and give first-class reception in any locality. High-fidelity reproduction is assured by the use of a special high-gain



Clipper Radiogram Model 725 K.G.

high-output pentode. The valves are English Rimlock types—well known for both reliability and availability. The circuit is conventional, but a great deal of attention has been paid to stability by the designers. All components are tropic-proofed.

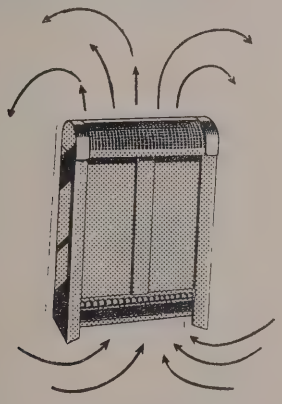
In both cases the cabinet is of a conservative design and solid construction. What they lack in novelty attraction, these cabinets make up for in their tried and proved good looks.

Clipper models are distributed throughout New Zealand by G. A. Wooller & Co. Ltd., Head Office, Box 2167, Auckland; branches at 50 Courtenay Place, Wellington, and 604 Colombo Street, Christchurch.

Clipper models are sold on an open franchise, and trade inquiries should go to any branch of G. A. Wooller & Co. Ltd.

* * *

"ROOMWARMA" CONVECTION HEATER



Manufactured by L. T. Hayman Ltd., Auckland, this new electric heater embodies all the latest features for efficient, economic "central heating." It can be used to heat one room or provide complete "central heating" by installing three or four heaters in various rooms in the home. Specifications are:

Heating Element: 2000 watts, 230 volts. Low-temperature element operates at "black" (infra-red) heat. Large helical coils strongly mounted on fireclay supports. Element guaranteed for FIVE years. Air ducts and all "live" parts completely guarded by mesh screen, top and bottom. Special "heat reflector" baffles ensure that exterior walls of the heater are cool to touch. Completely safe for children.

Automatic Thermostat: Best quality English 15-amp. **Room Thermostat** built in for easy adjustment. Can be set at any temperature up to 82 degrees Fahrenheit. Maintains even "room" temperature and allows maximum efficiency with minimum power consumption.

Safety Cut-out: A reliable mercury gravity switch is installed in the base of the heater. If heater is knocked over, element switches "off." Restore heater upright and element switches "on." An excellent fire-safety feature.

Pilot Light: Indicates when element is "on" or "off."

Air Flow velocity of air emitted from top of heater is 100 cubic feet per minute, at average temperature of 180 degrees Fahrenheit. Volume of air is 50 cubic feet per minute. Will change the air in a room of 1000 cubic feet three times every hour. The "Roomwarma" heats by circulation—cold air is drawn in through the base, and is heated, then deflected into the room by curved louvres in the top of the heater.

Installation: No costly installation is necessary. All that is required is a 3-pin wall socket. The "Roomwarma" is supplied with 3-core flex and plug ready for use. The thermostat is factory-set at 65-68 degrees before dispatch.

One "Roomwarma" should be installed for every 2000 cubic feet of space. For complete "central heating" in the average three-bedroom home, four or five "Roomwarmas" will ensure an even warmth throughout the home and at a fraction of the cost of other methods. No structural alterations necessary.

Design: Two models are available. The standard model measures 16 in. x 7 in. x 24 in. high, and is finished in the latest two-tone "hammer-finish" baked enamel. A neat handle on the back of the heater enables it to be easily carried from room to room if desired. Price: £16 14s. complete.

The console model is a combination book-case heater cabinet with four shelves covered with "Formica." Can be supplied with stained wooden shelves if required. The heater unit has the two-tone hammer finish, and will tone in with the best of surroundings. A really attractive useful piece of "all the year round" furniture and heater combined, it can be stood against the wall or in front of an open fireplace. No expense needed to build in to existing fireplaces, and enables the open fire to be used again at any time if desired. Measurements are: 27 in. x 8 in. x 30 in. high. Like the standard model, the console is cool all over—the heater body and shelves are completely insulated from heat by the special "heat reflector" baffles in the element assembly. This model is expected to sell at approximately £34.

Trade and public reaction to the prototypes of both models has been very favourable, and intense interest has already been created. Indications are that there will be a heavy demand for "Roomwarmas," and it would be advisable for "trade" inquiries to be made early.

* * *

A NEW E.M.I. CENTIMETRIC VALVE

From E.M.I. Factories Ltd., Hayes, Middlesex, England, comes news of a new 10 cms. three-band klystron, Type RK6112. This is a low voltage, reflex velocity modulated valve for use as a local oscillator in the 10 centimetre ("S") Band. It is of the plug-in type, with disc seals for reasonator connection, and is indirectly heated. It has a power output of

(Continued on page 47).

Personality of the Month

"R. & E." INTERVIEWS Mr. LESLIE GAMAGE

Recently this journal was accorded the privilege of an exclusive interview with Mr. Leslie Gamage, M.C., M.A., F.C.I.S., Vice-Chairman and Joint Managing Director of that great British firm, The General Electric Co. Ltd., England. Within five minutes of being put at our ease by a warm and friendly welcome, we began to wonder whether perhaps the role of interviewer had been reversed, and three-quarters of an hour later we departed feeling that the interview, from our point of view, had been all too short.

Having visited this country in 1936, Mr. Gamage is no stranger to New Zealand. On this return visit his first impressions were that our electrical and electronic industry has developed enormously in the past nineteen years. In some cases, Mr. Gamage considers that the quality of goods manufactured here equals, and sometimes exceeds, that of similar articles made in Britain. Others, of course, still leave something to be desired. Prudently refraining from amplifying this statement, Mr. Gamage went on to compliment our hotels, the comfort and service of which he thought had improved considerably since his last visit. He regretted, however, that, as yet, we had done little towards the establishment of a real tourist industry, and thought that our scenic attractions would remain an almost undeveloped asset until such time as we sent men to Switzerland for experience under the world's best hoteliers.

Questioned about the productivity and efficiency in terms of output per man hour of our factories compared with those of the United Kingdom and the United States, Mr. Gamage's reply was most illuminating. He considers that there is no basis of comparison between countries as different in size and population as these three. Production methods in each country were vastly different, and the methods used in each depended on the size of their potential markets. In America, factories were in operation which require supervision by only a few men, all processes being carried out automatically. Those few men, therefore, had an enormous output per man-hour, and such complete mechanization is possible only where the very largest markets exist. They would not necessarily be economic even in a country with the population of the United Kingdom, and in one of two million, quite out of the question. As a result, output per man-hour must decrease the smaller the potential market, and any basis of comparison must take this into account, said Mr. Gamage.

A matter which causes much concern, said Mr. Gamage, is the world-wide shortage of technical people. This did not only apply in the electrical and electronic industry, but was affecting all the skilled trades as well. In his opinion it was directly due to the fact that skilled occupations, at whatever level, entailed long training, with small or no remuneration at all during the period of training, which is a matter of years in length. Then, after having been trained, the skilled man found himself hardly better off financially than the unskilled labourer. Thus, the inducement to enter skilled occupations, apart from their inherent interest, was gone. It is a great problem, said Mr. Gamage, which would increase enormously should there be another war.

In a small country like New Zealand, Mr. Gamage considered that associations between large overseas firms, such as his own, and small but efficient and well-established firms here, could lead to valuable developments in our potential. The idea was not that large overseas firms should absorb a smaller firm in this country, but that the latter should have the benefit of the large concern's relatively enormous research and development facilities, and should also be able to obtain assistance by way of additional capital. Both these things, he said, would enable industry here to develop into spheres of activity which were previously denied to them by circumstances outside their control. Such an association was infinitely preferable, too, from the large company's point of view, to their attempting to set up factories of their own in places where the necessary knowledge of local conditions could not easily be acquired by men sent from abroad.

It was interesting to note that Mr. Gamage does not consider that the growth of secondary industry in New Zealand (at least in the electrical and radio field) has perceptibly affected our usefulness as a market for manufactured goods from the United Kingdom.

Finally, we asked him for his views on the desirability of to some extent de-centralizing the resources of Great Britain's electronics industry, more especially with a view to the situation that might arise in the event of a war. He did not consider that any really useful degree of de-centralization could be achieved, but he thought that it would be very desirable to have a nucleus of highly skilled and trained personnel here, who could direct the efforts of our industry in such an event. He realized, he said the difficulties attaching to the provision of such a body of men, especially as the knowledge they would require is mostly on the top secret list, and likely to remain so. He did think, however, that if it were economically feasible for us to have a television service here, it would do much good by way of raising the general standard of knowledge among radio technicians. He did not think, however, that we could possibly finance a television system in which each of the main centres had to originate its own programmes, and getting over this difficulty, using long-distance micro-wave links, was our only chance of having television here on anything like a national basis.

As a parting shot, Mr. Gamage expressed the opinion that within ten years (a period which after a moment's reflection he reduced to five) we would see world-wide television link-ups. Unfortunately, time did not allow us to ask him to elaborate on this one, but he certainly sent us away with more than a little food for thought.

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TRADE WINDS

SUNBEAM EXECUTIVE VISITS NEW ZEALAND

Mr. N. Doherty, Manager of the Electrical Appliances Division of the Sunbeam Corporation, recently paid a flying visit to New Zealand, chiefly on a goodwill mission.

During his stay, Mr. Doherty introduced to the trade two new Sunbeam appliances—a blender attachment to the Mixmaster, and the new Junior Mixmaster.

Mr. Doherty gave a luncheon for the trade at the Grand Hotel in Auckland, and later spent a weekend with Mr. George Wooller big-game fishing in the north.

Before leaving New Zealand, Mr. Doherty also visited Wellington and Christchurch and called on a number of major stores.

* * *

OVERSEAS TOUR—MR. D. H. WHYTE, A.M.I.E.E., BRITISH GENERAL ELECTRIC COMPANY LIMITED

Mr. D. H. Whyte, Engineer for New Zealand for the British General Electric Co. Ltd., also returned to Wellington recently and has come back to New Zealand enthusiastic about the latest developments seen during his tour of The General Electric Company's Works in Britain.

Principally concerned with heavy engineering, Mr. Whyte spent much of his time at the G.E.C. Works at Birmingham, Manchester and Coventry. Questioned about changes noticed since he was last there several years ago, he remarked on the considerable increase in the size of steam turbo-alternator generating sets now being manufactured. Whereas previously sets of 60,000 KWs. were considered very large, these are now comparatively small, 120,000 kW. sets being quite common whilst designs are out and manufacture will shortly commence on units having an output as high as 200,000 kWs.

The considerable increase in the size of the generating units is the result of the policy of the British Electricity Authority which, in its efforts to reduce coal consumption, is constantly seeking more efficient machinery for its generating stations. Much of the research and effort of the G.E.C. is devoted to this end, a new world efficiency record being created by one of their sets a short time ago.

During the last few years many developments have taken place, one of the most important being that concerned with semi-conductors. Besides the constant general research undertaken in this field, extensive investigations are being made at present into the application of these new materials to power work. Their current carrrying capacity is phenomenal, material of a diameter of only one centimetre being capable of carrying current of 300–400 amps. This current density is, of course, considerably higher than that normally associated with copper conductors under the usually accepted operating conditions. These high current densities do, however, bring about many other problems and a suitable solution has still to be found to dissipate the heat from the contact surfaces to prevent them from reaching too high a temperature. The main application for these new semi-conductors is for power rectifiers for traction and similar purposes.

Commenting on the general scene, Mr. Whyte remarked on the improved outlook of the general population since his last visit. There are plentiful supplies in the shops, coal being the only commodity still rationed. Though electricity is expensive, the easing of the hire purchase restrictions has led to an unprecedented demand for electrical domestic appliances, which, in turn, has been reflected in the expansion of those branches of the G.E.C. organization engaged in their manufacture. At the Coventry Works, devoted to the manufacture of telephone apparatus, radio and TV sets, 400 TV sets come off the production lines each day and the demand is for still more. Undoubtedly, considerable impetus is given to orders by the Radio and Radio Component Shows which have now become a firm feature of the trade.

Significant of the state of tension still existing in the world is the fact that, in Britain, an enormous percentage of the output of the radio and electrical industry is devoted to the Armed Services by way of the provision of radio, radar, telecommunications and remote control devices, to say nothing of navigational aids and associated apparatus. In this field also, the General Electric Co. Ltd. is bearing its full share of responsibility for research, development and production of equipment.

* * *

NEW SHOWROOM FOR PYE

Pye have now equipped their new office in Imperial Buildings, Queen Street, Auckland, with a smart new showroom. The photograph above shows only the radio side of the room. The other side has an impressive display of scientific instruments (being marketed by the newly-formed Special Products Division of Pye (New Zealand) Ltd.). At the far end of the showrooms are the glass-partitioned offices of the sales staff of the company.

The whole office is most impressive and will be a pleasant surprise to Pye dealers visiting Auckland.

VISIT OF SWEDISH EXPORTER

A welcome visitor to Wellington during March was Mr. Gosta Backstrom, of Messrs. A. B. Gosta Backstrom Ltd., Stockholm, Sweden, one of the principals of Fred Rothschild and Son, of Lower Hutt. Mr. Backstrom, whose firm deals in Algon Aerials, Sinus Speakers, Pearl Microphones, amplifiers, and microwave measuring equipment, visited New Zealand in the course of a world-wide goodwill tour of his firm's various representatives.

* * *

OVERSEAS VISIT FOR MR. C. E. FULLER

Mr. C. E. Fuller, Director and General Manager of the National Electrical and Engineering Co. Ltd., will be proceeding overseas in April for business discussions with his company's overseas principals, visiting Canada, the U.S.A., and Great Britain.

OVERSEAS TOUR—Mr. G. C. MARSHALL
British General Electric Co. Ltd.

Stimulated by his recent six months' "refresher" trip to the United Kingdom and Europe, Mr. G. C. Marshall of the British General Electric Co. Ltd., has returned to New Zealand deeply impressed by the organization and latest production methods of the General Electric Co. Ltd., whose products are handled in New Zealand by the British General Electric Co. Ltd.

With a staff of 65,000, the General Electric Co. Ltd. is a colossal organization with numerous factories throughout England and Wales, over 12,000 people being employed at the main works in gas lit "Electric Avenue" at Witton, Birmingham. Engaged in the manufacture of telephone and radio equipment, the Coventry Works also employs more than 12,000.

Of particular interest to Mr. Marshall were the G.E.C. activities in the three lines in which he specializes, namely, Electrical Measuring Instruments, Low Tension Switchgear and Electric Fans.

Salford, Manchester, with a staff of 4,000 is the main centre for the G.E.C. instrument manufacture at present, though ultimately the latter will be concentrated at the very modern new Works at Erith in Kent. Having just completed an order for the British Ministry of Supply for 1400 "Selectest" Universal Testing Instruments, and 8,500 B.P.O. No. 4 Detectors for the British Post Office, G. E. C. are now busy on a Ministry of Supply order for 3,100 hermetically-sealed measuring instruments of 2 in., 2½ in., and 3¼ in. One of the most interesting instruments invented and marketed by the G.E.C. is the Transducer, by means of which an alteration in pressure or a mechanical displacement is indicated remotely by an electric meter.

In the Low Tension Switchgear field, new items of interest to the New Zealand trade include 60-amp. triple-pole back-entry bakelite switches, the trade price of which will be only 10/6 in this country, and a composite unit domestic switchboard for surface and flush mounting to suit New Zealand conditions.

All G.E.C. new low tension switchgear exported to this country is very carefully tested, great care being taken to ensure guaranteed category of performance.

Readers will be interested to know that the G.E.C. and its associated companies are one of the largest manufacturers of electric fans in the world, five factories in England and one in India concentrating on these lines alone.

Birmingham and Walsall manufacture desk and ceiling fans, the Malayan market alone absorbing 18,000 ceiling fans every year. In beautiful surroundings in Essex, at Wood of Colchester Ltd., is the home of G.E.C. Propeller and Axial Flow Fans. Woods manufacture 10,000 different windings for fan motors, each year adding a further 300 to 400 to this total.

New lines include:—Silencers for use with axial flow fans. (These are ducts lined with glass fibre and held in position by perforated steel). A unit consisting of two silencers in series reduces the noise level of a fan from 96 to 81 decibels.

Radial Dampers—a beautiful piece of precision engineering, and a welcome addition to fan ancillary equipment.

Small 3 in. by 4¼ in. centrifugal fans of 1350 and also 2700 r.p.m., primarily for use with oil burners.

Woods also produce extra high temperature fans; the motor blades, etc. of these are guaranteed to operate successfully in a temperature of up to 340°F., and in a steam atmosphere.

Commenting generally, Mr. Marshall remarked on the rapid expansion of the electric domestic appliance market in the United Kingdom, due to the easing of the Hire Purchase restrictions. Naturally, this is reflected in the increasing orders for these products manufactured by G.E.C.

Highlights of the trip for Mr. Marshall were short visits to Paris and Southern Germany, and a tour of Switzerland. In this lovely little country, during a memorable journey in an open car from Interlaken to the Matterhorn district across the Grimsel Pass he saw various hydro-electric stations, and was able to make a thorough inspection of the State underground hydro-electric station at Innertkirchen. Numerous experiences of the magnificent electric train service in Switzerland culminated in a trip by rack and pinion train to the summit of the State underground hydro-electric station at the G.E.C. has installed a relay station in the Eurovision (European television) service.

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FOR THE TECHNICIAN

INSTRUCTIONS FOR SERVICING AN ATLAS TYPE B ELECTRIC RANGE

PART 2

8 in. Radiant Type Plate.—Raise the top; remove the nut holding the terminal cover on the hotplate connection box, thus allowing the cover and drip guard to come away, leaving the terminals exposed. Disconnect the appropriate wires, remove the hinge screw, and withdraw the hotplate. Each hotplate (radiant) is supplied with a reflector, and to obtain the best results it is necessary to keep it polished.

11 in. x 7 in. Grill-Boiler.—The same general remarks apply to this plate as to the 8 in. and 6¼ in. hotplates.

Thermostats

The thermostat has been adjusted and checked at the factory, and normally should not require any further adjustment. If a short-circuit occurs in one of the oven elements due to a boil-over or any other cause, it is essential that the operation of the thermostat be checked, after the repair of the element has been effected, to ensure that the silver points have not welded together.

To check this, turn the bottom element to "HIGH" and operate the thermostat control knob several times, noting that the indicator light goes on and off correspondingly. If the light remains on, the indications are that the thermostat points have failed. Make no attempt to repair the thermostat, but return it to Scott Brothers Limited, Christchurch or Auckland.

Servicemen should make certain that the thermostat is faulty before removing it from the range.

Testing.— Set thermostat control knob to 400 deg. Place a mercury type thermometer of at least 450 deg. Fahrenheit scale or a thermo-couple in the centre of the oven. Pre-heat oven, both oven element switches set to "HIGH" position until pilot light switches off. When pilot light switches off, turn top element switch to "OFF" position and allow thermostat to cycle for five minutes, to allow the oven to saturate and the temperature of the top element to equalize. The oven temperature may now be read and compared with thermostat control knob setting.

If a mercury thermometer is used, the reading must be taken very quickly, as in free air the temperature falls rapidly. With a thermo-couple instrument, the readings are taken externally and are therefore more accurate.

Adjustments.—Adjustments for temperature may be made to thermostats on the range.

Satchwell Types C.S. and V.C.S.

Only one adjustment may be made on these types of thermostats. The relationship of the control knob setting on the switch panel to the thermostat body indicator setting.

Method of Adjustment.—Set the indicator on the thermostat body to the 300 deg. calibration mark, also on the thermostat body. Remove the control knob from the shaft on the pilot lamp control. Insert special calibrated dial spanner, loosen locking backnut, and rotate dial spanner until the 300 deg. mark corresponds with the index mark on the range switch panel.

Should the oven temperature be registering low, say, 25 deg., set the dial spanner to 275 deg.; if the

oven temperature be registering high, say, 25 deg., set the dial spanner to 325 deg., the indicator on the thermostat body remaining at 300 deg. during these adjustments. Relock backnut tightly and replace control knob.

Pilot Light.—The standard pilot lamp is an ordinary 3.5v. torch bulb. The voltage is derived by shunting 3.0 volts off the neutral end of one bottom element spiral. Although the thermostat controls both top and bottom elements, the pilot light will only function when the bottom element switch is set to "HIGH" or "MEDIUM."

In some districts the 3.5v. bulb may burn out frequently and should be replaced by a 4.5v. torch bulb; the large-diameter glass cycle lamp type will not fit.

Thermostat Light.—If the light at any time proves defective, it may easily be serviced by the householder.

To Change a Bulb.—Loosen the small grub screw in the top of the knob and withdraw the knob. Pull the white bakelite cover away from the switch panel and remove the lamp holder from its locating clip. Note.—Before replacing a bulb, make sure it has not failed to operate owing to becoming loose in its holder or that the oven fuse has failed.

Diamond H. 2TH149 Thermostats

Dismantling and Fitting.—Great care should be taken during these operations to ensure that the capillary phial and tube are not damaged, bent sharply, or stretched. The tube has a very small aperture and is filled with a fluid under pressure, so any restriction will vary the pressure and so affect the thermostat operation. The manufacturers will not replace under guarantee any thermostat in which the capillary phial or tube has been cut or damaged.

Faults.—Thermostats are all tested and adjusted before leaving Scott Bros.' factory, but owing to transport and other factors the fine setting is sometimes disturbed. Practically all faults in this type of thermostat will occur in the capillary tube or phial. Faults in the switch body are unlikely unless a very heavy overload occurs. Faults in the capillary are indicated by the oven overheating, or the thermostat failing to cycle when the oven element switches are set to "HIGH" and the oven elements are functioning correctly. Failure of the capillary tube is caused by leakage of the fluid or the restriction of movement of the fluid within the tube.

Adjustment.—Only one adjustment may be made on a 2TH thermostat.

Method of Adjustment.—Set the control knob to 400 deg. Check temperatures as set out under the heading, "Testing." Remove the rubber cover located in the rear of the switch body and the adjusting screw will be found inside the ceramic base. If the temperature of the oven is found to be too low the adjusting screw is turned anti-clockwise. If the temperature in the oven is found to be too high, the adjusting screw is turned **clockwise.** One-quarter turn of adjusting screw represents approximately 25 deg.

To Adjust the Door Gaskets

First heat the oven to the normal operating temperature—about 425 degrees—and then test the fit of the door by placing a strip of notepaper between the door and the range front. The gaskets should grip the paper lightly along the top of the door and for three-quarters of the way down the sides, but should not grip it round the remainder of the door. This latter section should lightly grip three thicknesses of paper. If the gaskets require adjustment, endeavour to lightly tap down the high spots with the flat of a hammer rather than raise up the lower sections.

To Remove a Drawer Heater Element

Remove drawer as described under heading "To Remove the Utility Drawer." Raise the top and remove three screws from the rear of the back flange of the side. Withdraw the side from the range. Disconnect the two wires from the drawer heater terminals. Slacken the screws holding the drawer heater clips and swivel away, then remove drawer heater. Replace parts in reverse order.

To Replace an Oven Light

Open the door and remove the two screws supporting the oven light cover. Remove the armour plate glass which is clipped in position, then fit new bulb.

Note.—Should it be necessary to fit a new bulb, it is essential that only the specified type be used: Type, double contact, single filament, 12 volt 24 or 25 watt.

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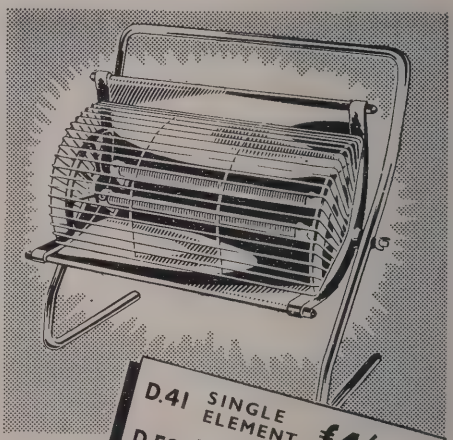
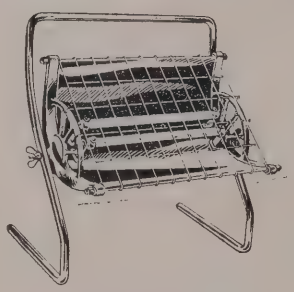
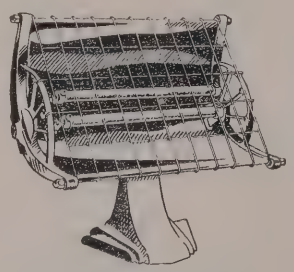


D.41 SINGLE ELEMENT £4/2/6
D.52 DOUBLE ELEMENT £5/2/6



C.31 Single Element £3.17.6
C.42 Double Element £4 19.6



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Publications Received

From Philips Electrical Industries of N.Z., Ltd.

Philips Serving Science and Industry, Vol. 1, No. 2, March, 1954.

From Standard Telephones and Cables Pty. Ltd.

A.T.E. Journal, Vol. 10, No. 4, October, 1954.

From C. & A. Odlin Timber & Hardware Co. Ltd.

Mullard Technical Communications (Overseas Edition) Vol. 1, No. 8.

Mullard Valves and Electron Tubes.

Mullard 5-valve 10-watt High-quality Amplifier Circuit.

Mullard Technical Data: Valves and Electron Tubes.

From British General Electric Co. Ltd.

Osram Bulletin, Vol. 31, No. 4, October, 1954.

From Turnbull and Jones Ltd.

Catalogue of Advance instruments and equipment.

From H. A. Parton Ltd.

Jenolite News, Vol. 6, Nos. 9, 10 and 11.

FOR REVIEW:

From John F. Rider Publisher, Inc., New York, U.S.A.:

Advanced Television Servicing Techniques, Vols. 1 and 2: prepared by RETMA Pilot Training Course Teaching Staff—Paul B. Zbar and Sidney Schildkraut.

TV Field Service Manual with Tube Locations, Vol. 3, Edited by Harold Alsberg.

TV Manufacturers' Receiver Trouble Cures, Vol. 6, Edited by Milton S. Snitzer.

General Publications Received:

A.P.A.E. Journal, Vol. 5, No. 8, Oct./Nov., 1954.

Electrical Industries Export, Vol. 54, No. 12, December, 1954.

The Gramophone, Vol. XXXII, No. 378, November, 1954.

N.Z. Electrical Journal, Vol. 28, No. 1, January, 1955.

N.Z. Electrical and Radio Trader, Vol. 1, No. 7, January, 1955.

Radiotronics, Vol. 20, No. 1, January, 1955.

Radio and Television News, Vol. 52, No. 5, November, 1954.

Wireless and Electrical Trader, Vol. 96, Nos. 1256-1259 incl.

Wireless Engineer, Vol. 31, No. 12, December, 1954.

Break In, Vol. 18, No. 2, February, 1955.

Elektrotehniski Vestrik, 1954, 9-10.

Labour and Employment Gazette, Vol. 5, No. 1, February, 1955.

O.S.T., Vol. XXXVII, No. 12, December, 1954.

Radio Constructor, Vol. 8, No. 5, December, 1954.

Radio Electronica, Vol. 2, No. 12, December, 1954.

La Radio and TV Revue, Vol. 6, No. 12, December, 1954.

"Machinery Lloyd," (Overseas Edition) Vol. XXVI, No. 9.

A New E.M.I. Centimetric Valve

(Continued from page 41).

100 mw. minimum, a frequency range (with suitable cavity of 2600–3700 Mc/s., resonator voltage* + 250 volts, resonator current 18–34 mA., reflector voltage* range of — 55 to — 350volts, reflector current of 4 Micro-amps max., cathode shield volts 0, Heater volts 6.3 volts, heater current 0.7 max. (*Measured with respect to Cathode). E.M.I. products are distributed in New Zealand by E.M.I. Suppliers, (trade division of H.M.V. (N.Z.) Ltd.), P. O. Box 296, Wellington.

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Fee: 15/- covers the three lectures.

For further details refer to Editorial on page 19.

Missing and Stolen Radios

Cromwell 5-valve table model radiogram, type 5151, serial No. 28109; walnut cabinet 12½ in. x 17 in. x 17½ in.; glass slide-rule dial, B.S.R. record changer, two knobs in front of cabinet.

Cromwell 5-valve A.C. radio, type 5151, serial No. 13404; walnut bakelite cabinet 8 in. x 12¼ in. x 6in., oblong dial, eliptical speaker, two white control knobs.

Cromwell 5-valve A.C. broadcast radio, serial No. 23499; ivory bakelite cabinet 8 in. x 12½ in. x 6in. with clock dial on left and walnut control knobs below dial, 6 in. x 4 in. eliptical speaker.

Phillips 4-valve A.C./D.C., model 146, serial No. 5341, licence No. 66772; two-tone maroon plastic cabinet with cream facings 10½ in. x 8 in. x 5 in., back screwed on, no aerial or earth leads.

Phillips 4-valve broadcast mantel model 126, serial No. 70321, licence No. 51987; walnut bakelite cabinet 10¼ in. x 6¾ in. x 5in., clear plastic slide rule dial with white station identification marks, 2 white control knobs.

WELLINGTON:

Phillips dual wave radio, serial No. 52473; green plastic case with crack from bottom rear corner.

Cromwell 6-valve, dual wave, table model radiogram, Model RC. 75M, serial No. 26181; polished wooden case and fitted with "Garrard" 3-speed record changer.

Ford auto radio tuning unit, serial No. 11177X; brown enamel case 9 in. x 6 in. x 3 in.

Philips 4-valve receiver, model 691, serial No. 1432; bakelite case.

CHRISTCHURCH:

Pacemaker 4-valve battery/electric broadcast radio, serial No. 32877; walnut plastic cabinet.

DUNEDIN:

Pathefinder 6-valve short wave model 559; light walnut cabinet 30 in. x 12 in. x 12 in.

Eddystone 15-valve communications receiver, model 680. Black crinkle finish metal case 7 in. x 9 in. x 14 in., with square dial, 5 wave bands. Lid opens at top to enter set. Radiogram switch and extra power outlet for radiogram at rear. Two can electrolytics blown and replaced by tubular ones, leaving two round holes in chassis about 2 in. to 3 in. in diameter. Faulty volume control. Two stainless steel carrying bars in front. Twelve controls in front of radio. "Jack" for phones at side.

AUCKLAND:

H.M.V. "Little Nipper", model 545 B.C., serial No. 28271, bakelite cabinet.

Skymaster, 5-valve radio, serial No. SN 39073, square, dark walnut cabinet, oblong dial, horizontal indicator.

PAPAKURA:

Mullard 5-valve model 522, serial no 3274; brown bakelite cabinet.

PUTARURU:

Akrad Five Star 5-valve, battery/electric receiver, serial No. S/N 7182, wine and cream coloured case.

ROTORUA:

Bell 5-valve portable, battery/electric receiver, serial No. B/p 1804; white plastic case.

LOWER HUTT:

Corvette Columbus 5-valve receiver, 1948 model, serial No. 76787.

Philips 5-valve, broadcast, mantel model receiver, serial No. 2864o.

RADIOS RECOVERED

Mullard, serial No. 50744.
Ultimate, serial No. 149508.

MISSING AND STOLEN ELECTRIC SHAVERS

TE AROHA:

Philishave single head, type 7735, serial No. 164519; cream colour, contained in leather case with zip fastener.

Philishave twin head cream colour, type 7743, serial No. 314490; contained in leather case with zip fastener.

Sunbeam Shavemaster, grey colour in grey leather case with zip fastener; serial No. A. 5305595.

Remington model 60, cream with brown mottling hair pockets; no serial No.

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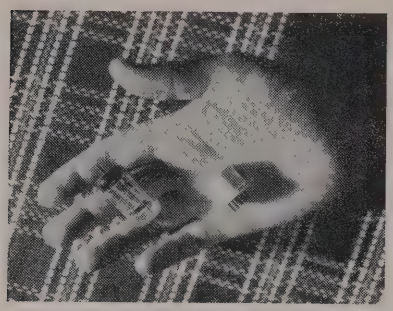

Compactness, in addition to extreme ruggedness, is one of the major advantages of the "stacked tube," developed by the Research Laboratories of Sylvania Electric Products Inc., as a component in electronic equipment. Illustrated above are a conventional vacuum tube, left, and a "stacked tube" in a ceramic envelope, both using the same size, 9 pin miniature basing. The "stacked tube" is less than half the height of the conventional tube, not including the latter's glass tip. The Sylvania tube development culminated in a development contract with the U.S. Navy's Bureau of Ships, and limited quantities for military use are now being produced at the Company's Kew Gardens, L.I., Product Development Laboratories.

The well-known firm of G. A. Wooller and Co. Ltd., of Auckland represent Sylania Electric Products Inc. in New Zealand.

PROTECTION OF ELECTRICAL EQUIPMENT AGAINST CORROSION

Electrical equipment in particular is subject to corrosive action and accordingly special care has to be taken in the maintenance of plant.

Since the war the value of chlorinated rubber as a basis for a corrosion resisting coating has steadily increased and Detel Products Ltd., of South Ruislip, Middlesex, England, well-known British pioneers in this field are now able to release several new varieties of interest to the export market.

Detel coatings fall into two categories, the first type protects surfaces by its impermeability and resistance and the second because of its chemical composition. The first category is the larger and gives a coat which is smooth and glossy and can be obtained in various colours. Impermeability is a particularly important feature as most films are permeable to water vapour and corrosive gases, especially when air dried.

Detel is best applied with a brush on the same lines as ordinary paint, and forms a tenacious, non-poisonous, and non-inflammable film which has remarkable properties of resistance to a wide range of acids and alkalies whether concentrated or dilute and other chemically reactive substances, including sea water. It possesses valuable electric insulating

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DIMENSIONS: 17 in. x 16½ in. x 9¼ in. Weight: 46 lb.

Compensated tone control for treble and base emphasis.

Cabinet in two-colour finish with two tape desk.

Recording sense: Top left to right (British and U.S. standard).

The "Grundig T.K. 819" has the same controls as its famous predecessor (the T.K. 9)—two-speed operation, extra recording time, and 4-5 watts output of a quality that simply must be heard to be believed.

Trade inquiries to: DIRECT IMPORTS (N.Z.) LTD.

BOX 72, HASTINGS

properties and one characteristic feature is the negligible water absorption, its insulating value being not materially reduced even after long immersion in water. The dielectric strength is equally striking, the breakdown pressure averaging 40,000 volts per m.m. thickness. Detel coatings also have in a marked degree, the property of water repellance. In a humid atmosphere water deposited on a Detel coated surface forms beads and not a continuous film so that electrical surface leakage is prevented. It is also unaffected by ozone, a point of importance in the manufacture of neon lighting in which ozone tends to be formed from the oxygen of the air by electrical action.

The second type known as D.M.U. (Detel Metal Undercoat) is by no means impermeable and depends chiefly on its high metallic zinc content (over 96%) for protecting iron and steel surfaces.

The use of powdered zinc as in D.M.U. primer has the advantage that any very slight electrolysis taking place attacks the zinc particles which are more easily affected than steel, D.M.U. provides a hard solid coat after exposure.

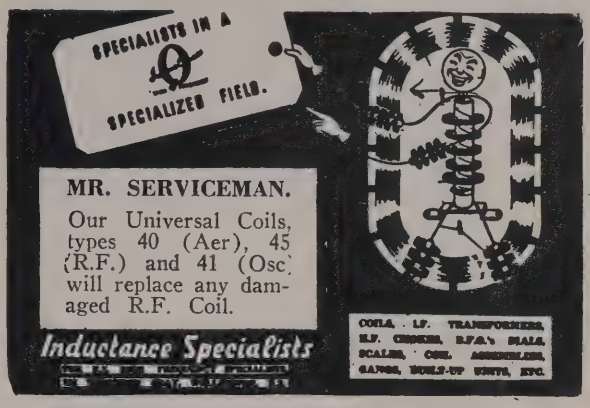
THE REMOVAL OF ATMOSPHERIC DUST FROM RECORD SURFACES

Two enterprising American scientists, Sam Messin of the U.S. Naval Air Missle Test Centre, Point Mugu, California, and J. S. Friedman of Mercury Scientific Products Corp., Los Angeles, have invented a "Disc-charger for the removal of atmospheric dust from record surfaces.

One of the most aggravating and annoying phenomena connected with the reproduction of phono discs is the presence of electrostatic charges which attract atmospheric dust to the record surface. These dust particles enter the record grooves and are bound to them by the invisible electric charges built up with each revolution of the disc.

Various atempts have been made to remove this dust, ranging from record brushes to wiping the record with a damp cloth before and after each play. Approaching this problem from another angle Messin and Friedman decided to investigate the use of radioactive materials for this purpose. It is a well known fact that radioactivity produces radiations which ionize the air, reducing or inhibiting the formation of static electricity.

Their experiments indicated that a minute quantitiy of radioactive material, when mounted on the pickup arm and allowed to scan the revolving disc, was found to be adequate for the purpose. With this method of scanning, a capsule containing the radioactive material can be produced at nominal cost.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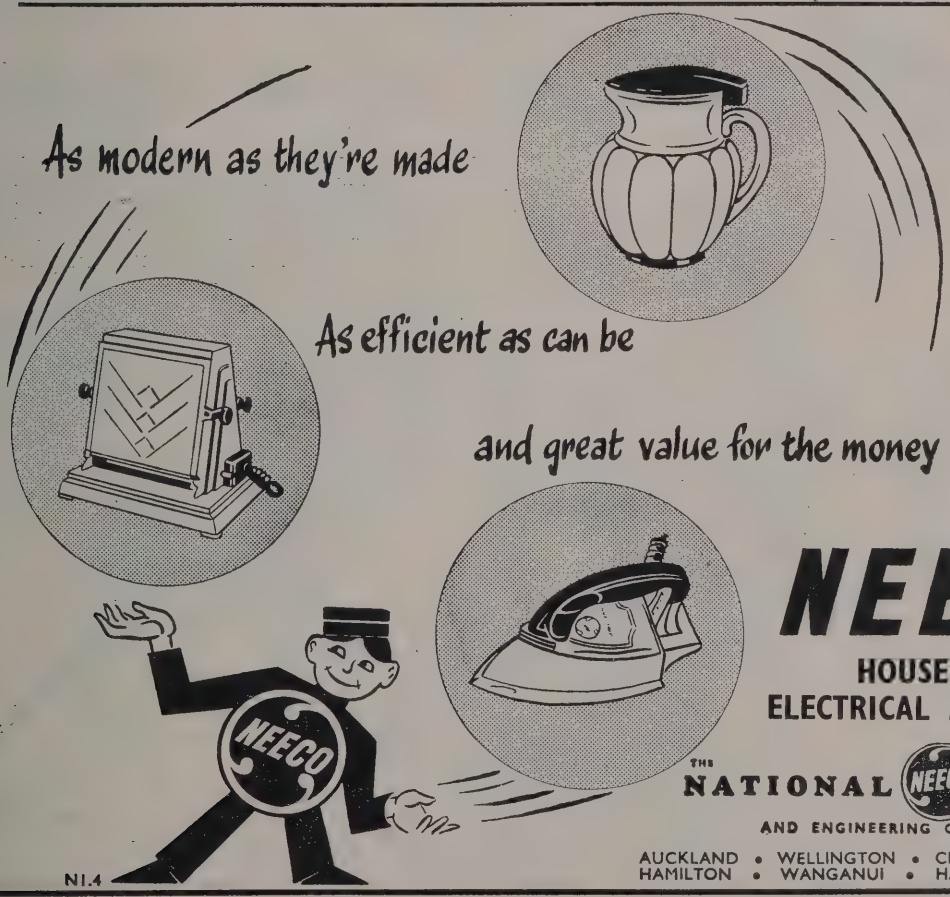

Preamplifier and Tone-control

(Continued from page 33).

within the extremities indicated. Thus, it is possible to have a flat response from extreme lows to extreme highs, or any desired amount of either boost or cut at each end. As a matter of interest, the curve obtained when both controls are fully anti-clockwise is B to D, and this is the response of the first network in the description which we gave in Part I of this article, of the working of the tone control circuit. It will also be noted that there is a pronounced roll-off above 10,000 c/sec. This is not due to the circuit, but to the pick-up which was used, together with a frequency disc in order to obtain the curves. The pick-up in question has this high-frequency roll-off itself, and had the curves been taken with an oscillator, with subsequent correction for the response compensation in the pre-amplifier stage, the result would be much as shown here, except that the top roll-off would not be apparent.

Audio Output Meter

(Continued from page 23).

our practical case, the secondary terminals look to any circuit to which they are connected exactly the same as a resistor of 250k./400, or 625 ohms. Obviously, connecting 625 ohms across a load resistor of 16 ohms will have only a negligible shunting effect, and will not alter the amplifier conditions to any observable extent. It is true that for lower load resistances, the effective shunt resistance will be lower than 625 ohms, because in these cases the step-down ratio of the transformer is greater, but in every case, the ratio between the load resistor and the shunt resistance of the meter transformer will be the same. For the 1 ohm load, for example, the effective shunt resistance will be 42 ohms.

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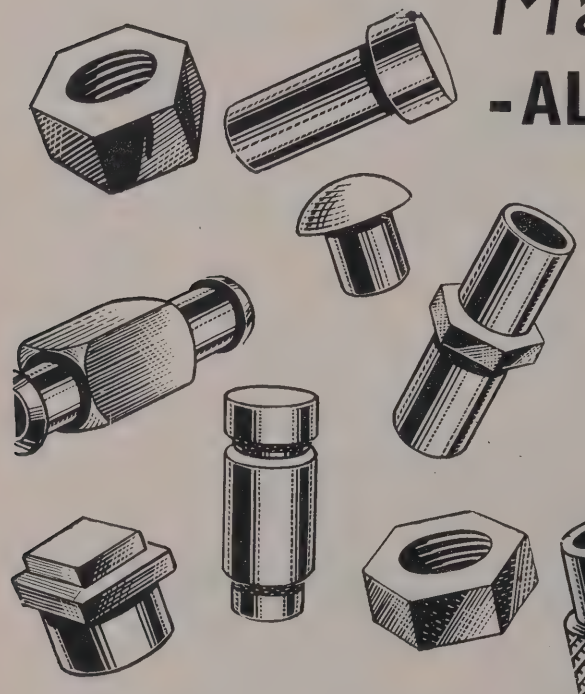

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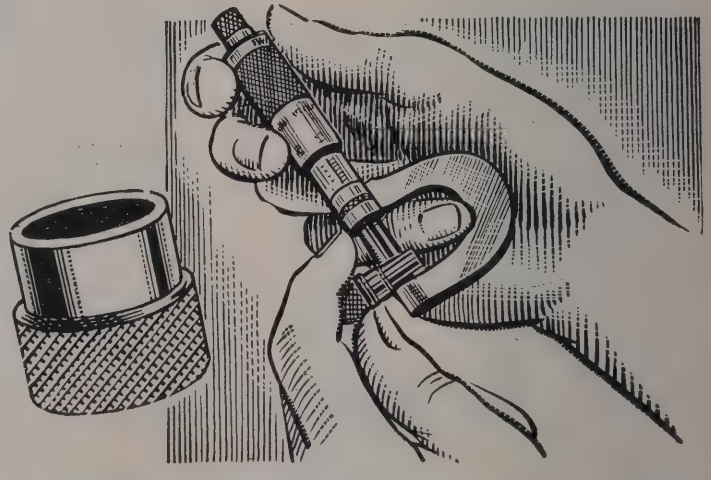

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Refrigeration

(Continued from page 39).

Care must be taken when selecting a thermostatic valve to ensure that a suitable valve is used. In general, four types of thermostatic valves are in use: (1) Single-bellows gas-charged valve; suitable only for normal temperature applications and where the valve body is at all times at a higher temperature than the feeler bulb; by limiting the evaporator pressure and so the suction pressure at the compressor, overload of the motor is prevented; this valve is not recommended for low-temperature applications. (2) Double-bellows gas-charged valve; this valve overcomes to a large extent the trouble which may be experienced with the single-bellows gas-charged valve, but at the same time by limiting its maximum operating pressure gives protection to the motor; this valve can also be used on low-temperature applications. (3) Single-bellows liquid-charged valve; this valve is suitable for low-temperature applications or those where the valve must be located in the refrigerated space, but gives no motor protection during "pull-down period." (4) Single-bellows specially-charged valve; this valve gives a performance between that of a gas-charged valve and a liquid-charged type; it can be installed in any position inside or outside the refrigerated space and will give limited protection to the motor during the "pull-down period"; it is essential that the orifice of the valve selected be of a size suitable for the capacity of the condensing unit.

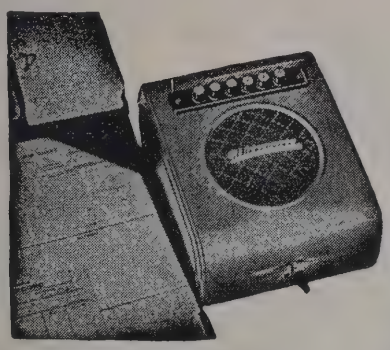
Record Talk

(Continued from page 35).

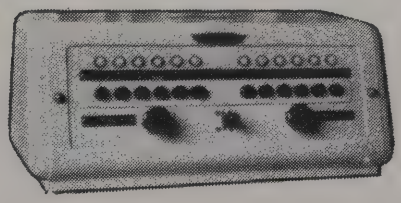
corded almost uncut on six sides, with singing that is nearly always thrilling and orchestral and choral work of a standard one has a right to expect from Italy's number one opera house. I cannot see that any true lover of Italian grand opera could bear to be without this set.

Other makes in this month's releases must be treated briefly. From Parlophone: two Handel concertos recorded in Copenhagen (PMA 1021), the first version in many years of Balakirev's symphonic poem "Thamar", conducted by Fistoulari and coupled with a suite from Rimsky Korsakoff's "Ivan the Terrible" (PMC 1009) and, last but not least, Jimmy Shand on LP! This is bounty indeed—eightsome reels, waltzes, jigs strathspeys, all on PMD 1012. Brunswick offer music from the sound track of "The Glenn Miller Story" on LA 8647, more Ballads and Blues by Josh White on LA 8653, and a record of gypsy tunes by Victor Young's Singing Strings on LAT 8033. There are also several highly interesting discs of old French and Italian music by a vocal and instrumental ensemble under the famous French teacher and musicologist, Nadia Boulanger. From Decca come several demonstration records dealing with various instruments—clarinet, saxophone, trombone and trumpet have a disc apiece (LX 3129-32). Artists and music are French, so are the instruments, produced by Selmer. The players are heard both solo and accompanied by piano, and the trombone record actually contains works for four of these impressive instruments. From London we have a further crop of 10 inch jazz records for the specialist, some vintage offerings being included.

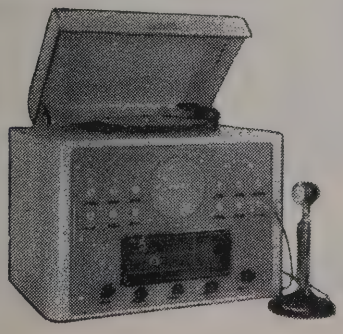
"R. & E." Audio Lecture Demonstrations
14th, 21st, 28th May, 1955—See Editorial.



Intercommunication



Control Equipment



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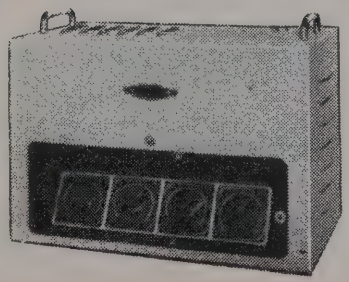

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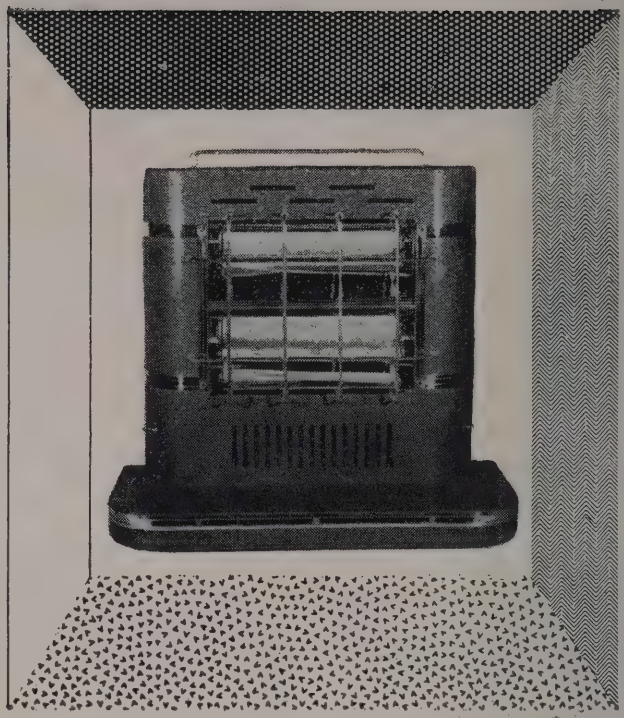

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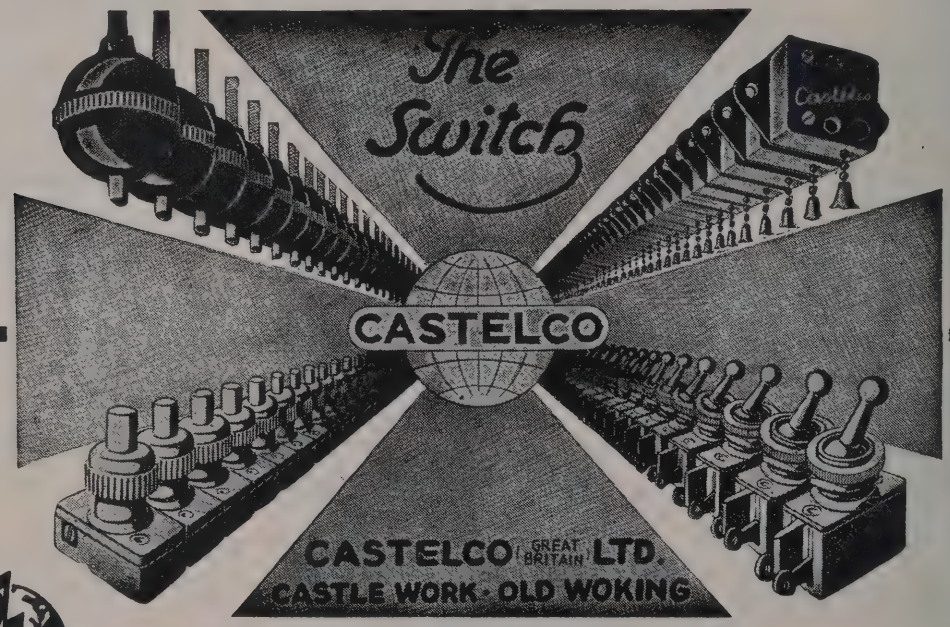

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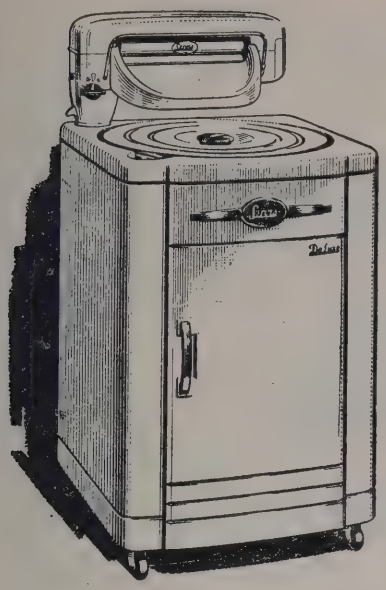

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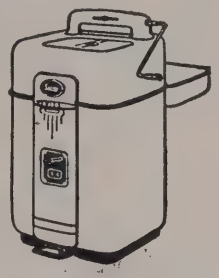

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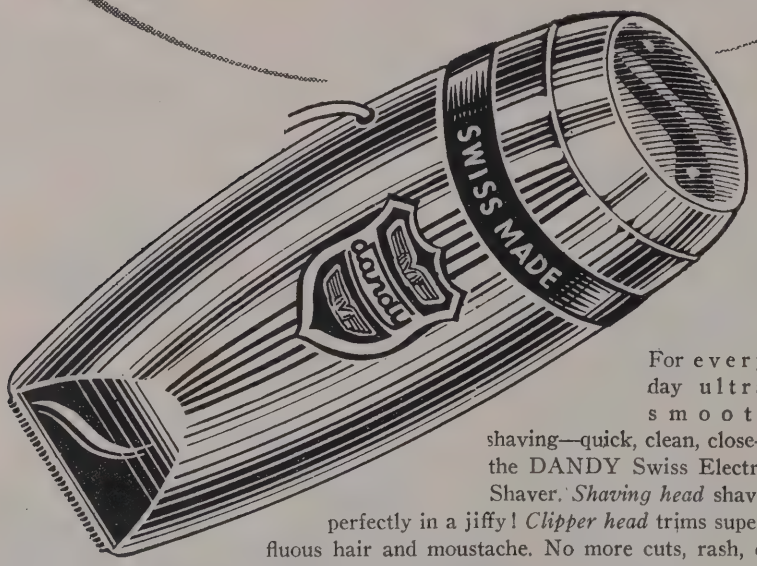

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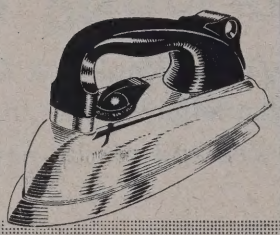

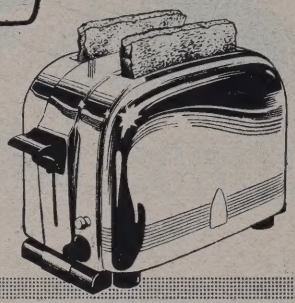

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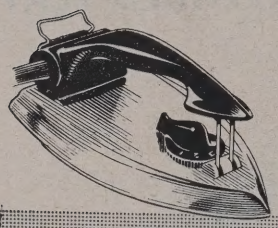

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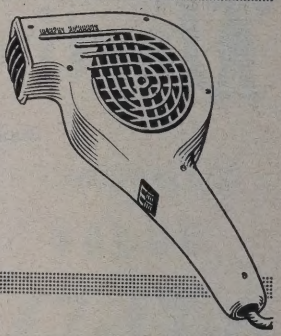

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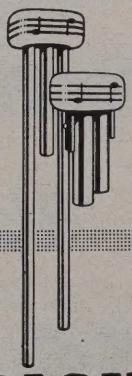

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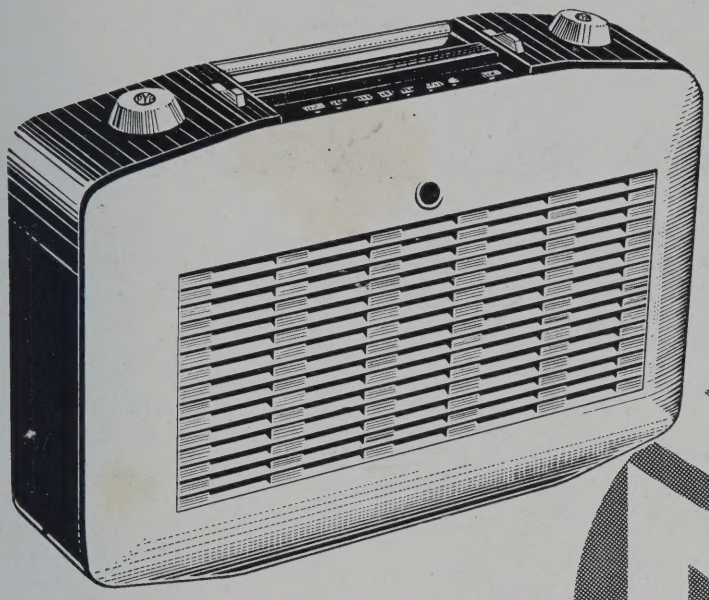

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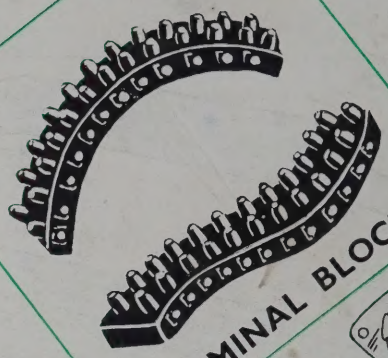

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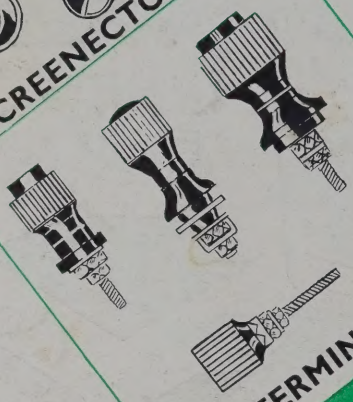

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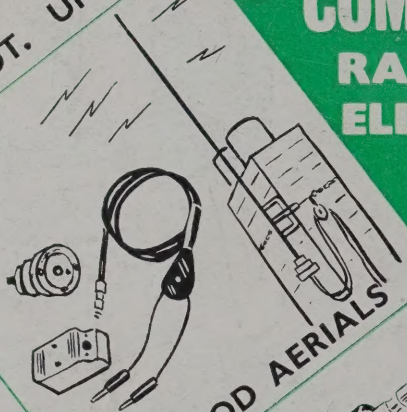
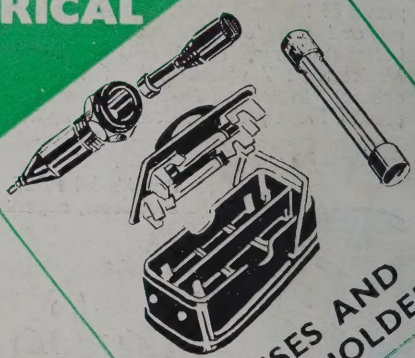
COMPONENTS

RADIO AND ELECTRICAL

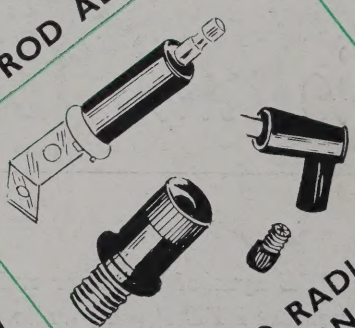


SKYROD AERIALS



FUSES AND FUSE HOLDERS

MULTIPIN CONNECTORS



AUTO RADIO SUPPRESSION EQUIP.

NOISE SUPPRESSION EQUIPMENT

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